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Was this Accidental? Secretary of the Navy Daniels announced a few days ago that he wished to have representatives of different engineering societies in the United States appointed to consult with the Navy Department regarding the best methods of bringing the navy up to its highest efficiency. It seems strange that he should ask for representatives of almost every technical society in the United States except the one that can be of more real service to the navy than all of the others put together. We refer to the Society of Naval Architects and Marine Engineers. Was this an accidental oversight, or was it intentional because of the fear that some information might be given that he would not care to have brought before the Navy Department?

Bureau of Naval Inventions There can be no question as to the advisability and importance of utilizing in the most efficient manner the inventive ability of the people of the nation for the development and improvement of its navy. Each step in advance in the construction and operation of a naval fighting machine depends not only upon the practical knowledge of the men who are devoting their lives to naval service, but also to the countless inventions, discoveries and modifications made by scientists, engineers and mechanics working in fields not even remotely connected with naval construction. In the Navy Department, as previously conducted, limitations in authority and expenditures and Government "red tape" have undoubtedly delayed the adoption, or development, of useful inventions perfected by manufacturers for other purposes. There has also been a lack of means for encouraging men with inventive ability to make a special study of naval needs and requirements with a view to effecting improvements. If the Bureau of Naval Inventions, now in process of formation by the Secretary of the Navy, can be made to provide a practical method for stimulating the development of inventions especially for naval purposes, it will serve a useful purpose, but if the new Bureau is to act simply as an advisory committee to pass upon the practicability of new inventions for naval uses, there is little reason to believe that greater progress will be made than has already been accomplished by the experienced naval officers who direct the special work of the various bureaus in the Navy Department. No other class of men is more competent to judge the usefulness of new devices for naval purposes than the naval officers themselves, who direct the lines of development and policies of the various departments. On the other hand, if the Bureau of Naval Inventions proves to be a means of placing at the disposal of the Navy Department the most highly skilled and ablest men of the country for the actual work of solving special problems and adapting meritorious inventions to special lines of development for naval construction, it will open a field of vast possibilities. How effectively this can be accomplished remains to be seen. At all events, it is to be hoped that, by fostering the inventive resources of this country for its own needs, the Navy Department will no longer be forced to depend upon the initiative of foreign countries for necessary improvements.

The Eastland Disaster Until a thorough investigation has been made, the actual cause of the capsizing of the passenger steamer *Eastland* at her landing in the Chicago River, resulting in the loss of over eleven hundred lives, cannot be determined. It is evident, however, that negligence or incompetency on the part of some group of officials connected with the operation of the vessel was responsible for the appalling disaster. Both the Federal steamboat inspectors and the officers and crew of the vessel must face a most searching inquiry before the responsibility for the accident is fixed. During the twelve years that the *Eastland* has been in service she has been frequently used as an excursion boat, carrying large numbers of passengers under much the same circumstances as when the lamentable accident occurred. According to reports, she has been known among navigators on the lakes as a "cranky" boat with a lack of stability, which would indicate either that her design was faulty or that she was not being operated under the conditions of loading and ballasting for which she was designed. The reports also state that water ballast was necessary to maintain the stability of the vessel. If the water ballast tanks were not properly filled, there is every reason to believe that this would be the primary cause of the accident. If the vessel were improperly designed and unsea-

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worthy, the sacrifice of 1,100 lives—not to mention other recent marine disasters—should be a sufficient warning to the public to create a demand for a steamboat inspection service that is capable of passing upon the designs of new ships, and that is invested with power by Congress to approve of such designs before the vessel is built. The Steamboat Inspection Service, as at present constituted, apparently has neither the power of approval of proposed designs nor the facilities for doing such work. A rule was promulgated by the Board of Supervising Inspectors four years ago requiring the owner of every new vessel over 100 gross tons, when making application for the first inspection of the vessel, to file with the local inspectors of the district where the vessel is to be inspected complete drawings of the hull of the vessel as a record for reference, so that the inspectors can become familiar with constructive details which otherwise could not be ascertained by the regular inspection after the vessel was built.

The Steamboat Inspection Service has given consideration to this very subject, but, so far, no steps have been taken to secure the necessary authority, or appropriations, for carrying it into effect. If such a plan is not feasible, some other way of obtaining the desired result should be devised. At least the Board of Supervising Inspectors should include one or more experienced shipbuilders or naval architects of recognized ability, competent to pass upon proposed designs and invested with authority to compel necessary alterations, so that every vessel certified to carry passengers will have at least the necessary stability and seaworthiness to insure the safety of its passengers under every condition of operation.

Growth of American Merchant Marine

The tonnage of vesels added to the American merchant marine during the fiscal year ended June 30, 1915, amounted to 744,618 tons, which is the largest annual addition to the American merchant fleet in the history of the United States. Other record years were 1908, when the total increase was 718,683 gross tons; 1907, with 596,708 gross tons, and 1855, when the increase was 586,102 gross tons.

In previous record years, however, the total addition consisted wholly of vessels built in the United States, whereas during the past year 528,907 tons, or 71 percent of the shipping added, consisted of foreign-built vessels admitted to American registry under the ship registry act of August 18, 1914. The number of merchant vessels actually built in the United States and officially numbered by the Bureau of Navigation during the past fiscal year was 1,226 of only 215,711 gross tons, as compared with 1,291 vessels of 311,578 gross tons for the fiscal year 1914.

The principal vessels built during the fiscal year 1915 were the colliers *Achilles* and *Ulysses* of 11,081 and 10,910 gross tons, respectively, built by the Maryland Steel Company for the Panama Canal trade. Other vessels over 5,000 gross tons included the oil tank steamer *John D. Rockefeller* of 8,374 gross tons, built by the Newport News Shipbuilding & Dry Dock Company for the Standard Oil Company; the 23-knot turbine passenger steamers *Great Northern* and *Northern Pacific*, of 8,255 gross tons each, built by the William Cramp & Sons' Ship & Engine Building Company for the Great Northern Pacific Steamship Company, and the *J. A. Moffett* of 6,395 gross tons and the *Lyman Stewart*, both oil tankers, built on the Pacific Coast. Only one large sailing vessel was built during the year, the *Georgia*, a schooner of 1,318 gross tons, while in all twenty-three steam vessels of over 1,000 tons each were built, aggregating 123,242 tons.

The losses to the merchant fleet for the past year have not all been reported as yet, but for the first nine months they numbered 1,062 vessels of 195,052 gross tons.

In June, the last month of the fiscal year (not previously reported in our columns), 176 vessels of various types, aggregating 16,767 gross tons, were built and officially numbered in the United States. Only six of these, of 7,943 gross tons, were steel steamships, the largest being the *Mariana*, of 3,063 gross tons, built by the Newport News Shipbuilding & Dry Dock Company for the New York & Porto Rico Steamship Company; the railway car ferry *Santa Clara*, built at Oakland, Cal., for the Central Pacific Railway Company, and the *International*, of 1,709 gross tons, built at Ecorse, Mich., for the Great Lakes Engineering Works. During the month three foreign-built vessels of 10,550 gross tons were admitted to American registry under the act of August 18, 1914, and up to July 17 the number of foreign-built ships added to the American merchant fleet had been increased to a total of 151 of 530,361 gross tons.

As the foregoing figures cover only the vessels completed or purchased during the last fiscal year, they do not indicate the present activity in the shipbuilding industry in the United States. The large volume of business that has filled the shipyards on the Atlantic Coast to full capacity, and which promises to keep them fully employed for several years to come, has all been booked since last December, and few vessels contracted for since that time have as yet been completed. The increased production in American shipyards, therefore, is not apparent in the official returns published by the Bureau of Navigation, although hereafter these reports will give a more accurate indication of the volume of this new business. In future also the tonnage added to the American merchant marine will not be influenced to such an extent by the number and tonnage of foreign-built vessels brought under the American flag in accordance with the special shipping act of August 18, 1914, as the largest steamship companies which could be directly benefited by this act have already taken advantage of the measure and transferred their vessels to the American fleet, and any additions to their fleets in the near future will undoubtedly consist of vessels built in American shipyards, as the conditions of the market at present are wholly favorable to American shipbuilders.

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Large Orders for Oil Tankers Placed with American Shipbuilders

At no time in the history of shipbuilding in the United States has the production of oil tank steamships been greater than at present. In all, twenty-three oil tank steamships, of a total of 209,200 tons deadweight capacity, are under construction. The Standard Oil Company is building seven ships of this type of 89,200 tons deadweight; the Petroleum Transport Company, three vessels of 30,000 tons; the Anglo-Saxon Company, a British firm, three vessels of 25,200 tons; the Gulf Refining Company, two vessels of 19,300 tons; the Texas Oil Company, two vessels of 18,200 tons; the American Molasses Company, two vessels of 14,000 tons; the Union Oil Company, one vessel of 10,300 tons, and the Mexican Petroleum Company, three of 3,000 tons deadweight.

Of these vessels seven of 79,800 tons are being built by the New York Shipbuilding Company, Camden, N. J.; three of 41,200 tons, by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; four of 32,700 tons, by the Harlan & Hollingsworth Corporation, Wilmington, Del.; four of 32,200 tons by the Fore River Shipbuilding Corporation, Quincy, Mass.; one of 10,300 tons, by the Union Iron Works, San Francisco, and one of 10,000 tons, by William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa.

Of the seven oil tankers building at the New York Shipbuilding Company's plant, four are for the Standard Oil Company of New York; two for the Gulf Refining Company, and one for the Petroleum Transport Company. All of the oil tankers ordered from the Newport News Shipbuilding & Dry Dock Company are for the Standard Oil Company of New Jersey. The order for three oil tankers for British owners was placed with the Harlan & Hollingsworth Corporation, and this company also is building one oil tanker for the Petroleum Transport Company. Two of the tank steamers under construction at the Fore River shipyard are for the Texas Company, the other two being for the American Molasses Company, while the orders for one large oil tanker each, placed with the Union Iron Works and the Cramp shipyard, came from the Union Oil Company and the Petroleum Transport Company, respectively.

The large orders for oil tank steamships placed in American shipyards are due partly to conditions brought about by the European war and partly to the natural expansion of the oil companies. With the oil fields in the northern part of France inoperative on account of the war, and transportation facilities from other oil-producing districts impaired, the supply of oil in such neutral countries as Norway has been seriously curtailed, causing advances in the price of fuel oil to as much as $24 (£5) per ton. Under such conditions the available supply of fuel oil in large quantities is limited almost wholly to the American oil fields, consequently the demand for tonnage for the transportation of American oil has caused the immediate expansion of the marine transportation facilities of these companies.

In the case of the Standard Oil Company of New York, a $15,000,000 (£3,080,000) subsidiary company has been incorporated known as the Standard Transportation Company, which has taken over the fleet of twenty-five vessels owned by the Standard Oil Company of New York, including six ocean tankers and half a dozen ocean-going tugs. As can be seen from the foregoing figures, four large tank steamers will be added to this fleet within a year, and two others will be delivered during the following year, making one of the largest oil-carrying fleets in the world.

Losses of Merchant Shipping

Approximate figures recently published show that during the first ten months of the European war 511 merchant vessels with a total tonnage of 915,457, representing about 2 percent of the total shipping of the world, were lost. At the outbreak of the war England's merchant marine amounted to 20,431,000 tons and Germany's to 5,082,000 tons. During the first ten months of the war England lost 609,934 tons of shipping, Germany 102,000 tons, Norway 47,000 tons, and France 42,000 tons.

The actual destruction of 2 percent of the world's merchant tonnage by the war, however, does not represent the most important effect of the war on merchant shipping during this period. Immediately after the outbreak of the war the construction of merchant vessels in the belligerent nations, which hitherto have been the largest producers of merchant shipping in the world, was virtually brought to a standstill. Practically all of the available resources for building ships in these countries were immediately directed to naval work, and, at the same time, the exports of manufactured products and staples from these countries rapidly decreased, so that the demand for new tonnage was correspondingly greatly diminished.

Taking the case of Great Britain, nearly 2,000,000 tons of merchant shipping were under construction at the end of 1913. At the end of 1914 there was a decrease of about 329,000 tons building. Again, at the end of the March quarter in 1915 there was a further decrease of over 40,000 tons, while at the end of the June quarter in this year there was a still further decrease of nearly 81,000 tons, making a total decrease of 25 percent in the tonnage of merchant vessels building as compared with the work in hand at the beginning of last year. As far as the British foreign trade is concerned, for the first five months of the present year the exports have shown a decrease of 30.24 and the re-exports a decrease of 16.92 percent as compared with the same period in 1914. Difficulties have also been experienced by British shipbuilders in obtaining capital, labor and materials, causing an abnormal increase in the price of merchant vessels and uncertainty as to their time of delivery.

Under these conditions, the combined effect of decreased production and lessened demand for tonnage has been far more disastrous to the shipping industry in the countries at war than the actual destruction of a small percentage of the world's shipping. In neutral countries, however, the reverse has been the case and both the shipbuilding and shipping industries have increased to a marked degree.

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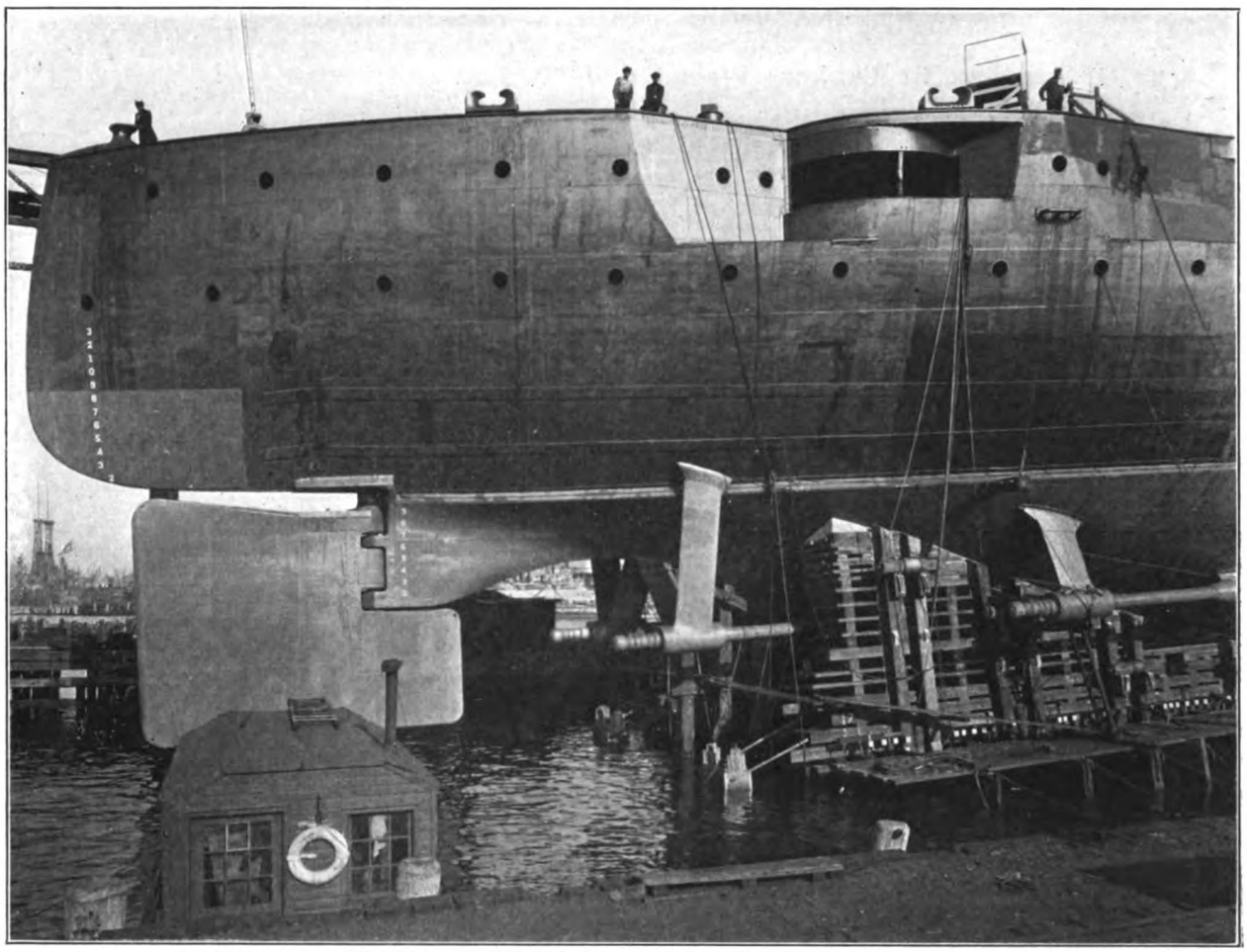

Launching of the Battleship Arizona

Construction of the Launching Ways, Fore Poppet and Cradle—Method of Release

BY G. H. BARBER

On June 19, at 1.09 P. M., the superdreadnought *Arizona* was launched into the East River from the New York Navy Yard in Brooklyn. The launching took place at the time set and was entirely successful throughout, reflecting great credit on those responsible for the working out of the details for the transference of the great mass of potential fighting material from the keel blocks and shores to the water.

The principal dimensions of the vessel are as follows: Length overall, 608 feet; length on waterline, 600 feet; breadth, extreme, 97 feet ½ inch; mean trial draft, 28 feet 6 inches; mean trial displacement, 31,400 tons; designed speed, 21 knots; motive power, Parsons turbines.

The launching weight, exclusive of the cradle and ways, was about 12,800 tons. This includes dunnage and interior shoring. The total weight on the grease amounted to about 13,350 tons. The corresponding weight of the sister ship *Pennsylvania,* launched in March at Newport News, Va., was about 14,100 tons.

The sliding ways and cradle were 70 inches wide and had an effective length of 505 feet. The initial pressure per square foot on the grease was about 2.27 tons, which is well within the maximum allowable for the yard building slip.

Special care was taken to prevent local straining and buckling of the ship, in wake of the thrust from the cradle, by the fitting of interior shoring. This shoring was designed to distribute the pressure into bulkheads, longitudinals and floors, and extended nearly throughout the extent of the cradle. In wake of the fore poppet the structure was most efficiently stiffened against crushing during pivoting by the fitting of 14-inch by 14-inch yellow pine cross braces on each frame and half frame. These braces set into wooden shoes shaped to fit against the inner bottom, the inner bottom being well shored against the outer shell. No signs of strains or deformations were found after the launching.

The fore poppet was of the well-known "trunnion" type, which had proved very satisfactory in launching the U. S. S. *New York.* The sliding faces of the trunnion had a radius of 50 feet and a fore and aft length of about 23 feet. One of the features of the fore poppet was the means taken to carry the location of same as far forward as possible. This was done in order to reduce the pivot-

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ing pressure and gain additional length of sliding ways for reducing the unit pressure on the ways. As the ship was not wide enough, at the point selected, for the fore poppet, to afford effective bearing for the cradle, three medium steel plate slings extending under the ship from side to side and having suitable brackets attached, were built so as to virtually form a false shell far enough from the centerline of the ship to give the required effective bearing area. Through the tops of the sling plates steel wire rope lashings were passed and made fast to clips bolted high up on the shell. These lashings were later used for removing the entire fore poppet by slacking away and carrying them forward of the bow, and so allowing the fore poppet to fall clear of the ship.

The space between the shell and the slings was filled with a concrete mixture of 1:3:5, a fine meshed stone being used. The concrete was poured some three weeks

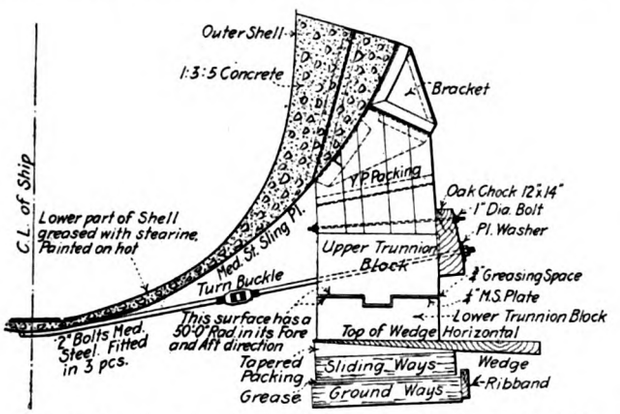

Fig. 2.—Section Through Fore Poppet, Starboard Side Looking Forward

previous to the launching. The effect of this arrangement (see Fig. 2) was, of course, to give the ship temporary increased width locally as required. The under portion of the shell in wake of the concrete was greased with stearine, painted on hot, and the concrete was tied back to the slings by perforated flanged plates bolted to the slings to prevent failure or shifting of the concrete under the pivoting pressure.

The assumed pivoting pressure for which these slings were designed was 2,700 tons, while the actual pivoting

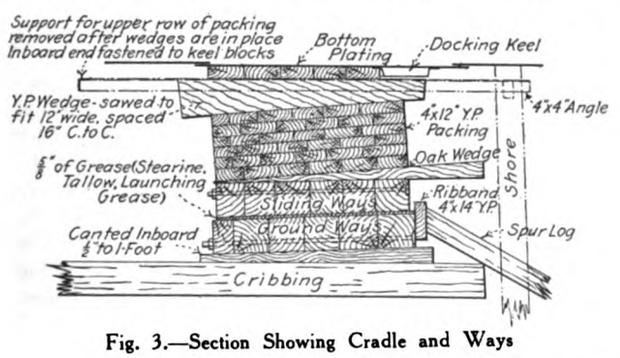
Support for upper row of packing removed after wedges are in place Inboard end fastened to keel blocks
Bottom Plating
Docking Keel
Y.P. Wedge - sawed to fit 12" wide, spaced 16" C. to C.
4"x12" Y.P. Packing
4"x4" Angle
Oak Wedge
1/2" of Grease (Stearine, Tallow, Launching Grease)
Ribband 4"x14" Y.P.
Sliding Ways
Ground Ways
Shore
Canted Inboard 1/2 to 1 Foot
Spur Log
Cribbing

Fig. 3.—Section Showing Cradle and Ways

pressure was slightly less, being about 2,650 tons. The trunnions functioned properly, rotating through an arc of about 27 inches.

The cradle was made up for the most part of 4-inch by 12-inch yellow pine planking, fitted longitudinally, as shown in Fig. 3. The upper row of packing was fitted to the shell and held in place by 4-inch by 4-inch angle iron beams spaced at intervals. After the lower packing had been placed on the driving wedges the upper wedges were cut to suit and driven home and the angle irons removed. At the forward and after ends 12-inch by 12-inch yellow pine timber fitted to the shell was used. The character of the after cradle is shown in the photograph

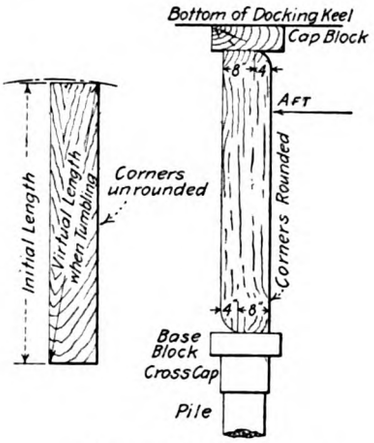

Fig. 4.—Tumbling Shores

(Fig. 1). The cradle was held in place by nine steel wire rope frappings, two forward and seven aft.

The manner of supporting the ship up to the time of releasing is worthy of note. About a month prior to the launching some fifty alternate keel blocks were removed, working from forward one at a time and sand blocks substituted therefor. The sand block is made up of a box composed of channels, bolted together at the corners and closed top and bottom by fitted oak pieces. There is a space of about two inches between the inner faces of the two oak pieces, which is filled with dry sand. To remove this type of block the corners need only be unbolted to

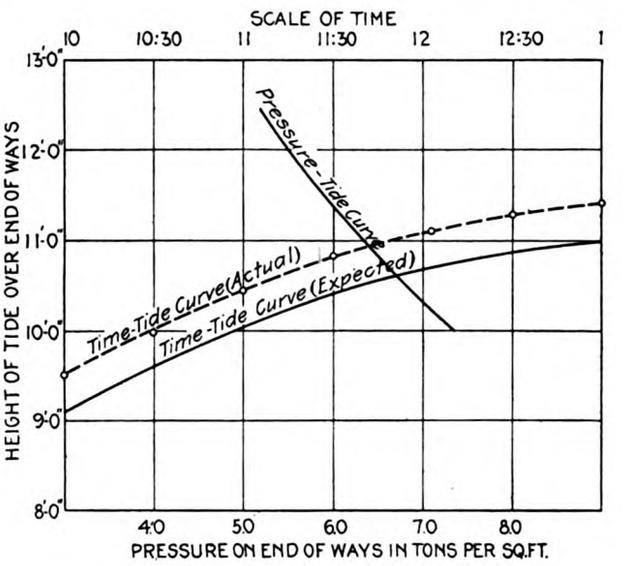

Fig. 5.—Tide and Pressure Curves

allow the sand to flow, when the whole block with supports may be quickly removed.

All keel blocks aft of the point where the low water level crossed the lower stringers were removed gradually, as occasion offered, some six weeks before the launch, and tumbling shores fitted in place thereof. These shores were rounded off at their top forward and bottom after ends, thus allowing them to tumble when the ship started to

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move down the ways. These after-tumbling shores were roped to the packing to be carried out with the ship, thus preventing their piling up and fouling the bottom of the ship or the lashings of the fore poppet. Also under the outer docking keels the regular shores were converted into tumbling shores under alternate frames.

After all the side shores and cribs had been removed the ship was still very well supportetd on the tumbling shores and sand blocks. The fifty sand blocks were removed in about ten minutes just before releasing. By the use of the sand blocks and tumbling shores the hard work and uncertainty attendant upon removing the last keel blocks and shores were avoided and the ship was supported until the last possible moment before it started down the ways.

When tumbling shores are used particular attention must be paid to the amount of round given to the top and bottom of the shore. It is apparent that if no round were given to the corners the virtual length of the shore in tumbling would become that of the diagonal. This would result in either the holding of the ship or in local deflections of the structure, if the ship should push by. Experience with these shores, which were also used on the *New York* launching, shows that they operate successfully when rounded off about one-third the diameter or face width at top and bottom.

Hydraulic Releasing Trigger

The releasing device used was the hydraulicly operated trigger, there being one fitted for each way. They were so connected as to be operated together by the turning of a valve which released the fluid contained in the hydraulic cylinders. The fluid was a 30 percent mixture of glycerine and water. The trigger consisted of a bell crank of special forged steel, the upper end bearing against the sliding ways and the lower end bearing against a piston sliding in a cylinder fastened to the ground ways. The trigger turned about a pin through its central point, the pin seating in a casting attached to the ground ways.

The triggers were located in pits beneath the ways at about frame No. 69. A cross passage gave access from one pit to the other. All the operations were directed from the starboard pit, which was connected by voice tubes with stations at the port and starboard sides on the ship and at the forward end of the ways where the starting rams were located. The starting rams had a capacity of 250 tons for each side.

A dog shore was fitted on each side aft as a precaution against a premature release of the vessel. This shore was made of 14-inch by 16-inch oak timber, iron shod at each end. The forward end bore against a chock, which was bolted to the sliding ways, while the after end was rounded and turned in a shaped log bolted through to the cross caps on the piling. The shores had a fore and aft slope of 1½ inches to the foot. The dog shores were not called into use and were dropped clear just prior to the release of the ship.

One of the interesting minor details was the plan showing curves for height of water over the end of ways plotted on a time base, and also the maximum bottom pressures for varying heights of tide. The curve of expected tide, the highest point of which had been used in making the launching calculations, was plotted from 10 A. M. to 1 P. M. The actual height of tide was obtained on the 19th and plotted at one-half hour intervals, thus indicating whether the actual tide would be under or over the expected tide. The maximum bottom pressures or thrust from the end of the ways in tons per square foot was plotted on the height of tide for values between a 1-foot higher and a 1-foot lower tide. The actual maximum bottom pressure at the moment of release could then be seen at a glance. This maximum pressure for the *Arizona* was about 5.8 tons per square foot.

The removal of the 500 odd tons of cradle was provided for before launching. Wire rope lashings were passed around the cradle and carried up to the main deck. Rider logs were fitted above the cradle at intervals and carried outboard as far as the docking keels. The under side of each log was painted with stearine. A wood chock fitted to the shell and connected to the docking keel by a plate bracket carried the outboard end of the log and kept it lower than the docking keel, so that no damage could be done to the docking keel in pulling out the cradle and so that the cradle would slide by without jamming. Likewise in wake of the bilge keels tapered chocks were fitted so as to allow the cradle to slide freely by and without damage to this keel.

The usual observations for hogging and sagging by means of a transit and sighting batteries were made; no appreciable hog or sag was found. The velocity was obtained by four pairs of observers working independently. The time when certain distance marks, painted on the ship at the level of the armor shelf, passed the observers was noted on paper strips pasted on the dials of stop watches, the watches being started at the instant the vessel began to move. The maximum observed velocity was 21 feet per second, the maximum acceleration was 1.4, and the minimum coefficient of friction derived from the acceleration was .01.

The vessel was afloat in about 42 seconds. It ran to midstream and about half the distance to Williamsburg bridge. It was then taken in tow and brought to Pier D, where the vessel is now being completed.

The Superiority of Tungsten Lamps for Lighting Ships*

BY L. C. PORTER †

The use of tungsten lamps aboard ships offers several exceptional advantages. Space and weight are of considerable moment on board modern high-speed passenger vessels. Reliability is also of great importance. Repairs when necessary must frequently be made at short notice and without most of the facilities obtainable ashore. The use of tungsten-filament lamps, consuming approximately 1.10 watts per candle-power as against 3.10 to 3.50 by carbon-filament lamps, means smaller and lighter generating apparatus, lighter wiring throughout the ship, less coal storage space necessary, etc.

It frequently happens, when changing over the lighting equipment of a ship from carbon lamps to tungsten lamps, that one generator may be shut down and held in reserve. Smaller and lighter storage batteries for emergency use are required for tungsten lamps than for carbon lamps.

The lighting problems of passenger vessels may be divided into five main parts: (1) social halls, (2) dining rooms, (3) smoking rooms, (4) staterooms, and (5) passageways. In addition to these there are certain parts of the ship where a relatively small number of lamps are used, such as engine rooms, bar rooms, barber shops, boiler rooms, freight holds, etc.

Investigation shows that there are two general types of steamers in the coastwise, river, and lake class, those making comparatively short runs and those making trips of several days. On the former, the social halls consist of a large well, or opening, running up one or two decks

* Extract from an article on The Lighting of Ships in *The General Electric Review*.

† Edison Lamp Works, Harrison, N. J.

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above the main deck. This class of social hall is well illustrated by the photograph taken on the Fall River Line steamer *Priscilla,* Fig. 1. On ships making long trips, the social halls are smaller and generally but one deck high. Also they are usually not lighted quite as elaborately. Ceiling lamps are found frequently supplemented by lamps in wall brackets.

Illumination measurements, taken on a large number of ships lighted with carbon lamps, showed an average foot-candle intensity, on a plane three feet above the floor, of 1.1 on long trip ships, and 1.5 for the short run class.

Fig. 1.—Saloon of Steamship *Priscilla* of the Fall River Line

An interesting demonstration of the great improvement obtained by substituting tungsten-filament lamps for carbon lamps was made in the social hall of a boat of the short run type. Thirty-eight 60-watt, all-frosted carbon lamps, giving an average intensity of 1.4 foot-candles for an energy consumption of 2.3 watts per square foot, were replaced by thirty-eight 25-watt, all-frosted tungsten lamps. These lamps gave 2.7 foot-candles illumination with an energy expenditure of 1.0 watt per square foot.

Dining rooms are very similar on each class of ship.

Fig. 2.—Dining-room of the *Adirondack* of the Hudson Navigation Company

Round-ball enclosing globes located on the ceilings were considerably used. On one ship the 16 candle-power clear carbon lamps in enclosing globes were replaced lamp for lamp by 25-watt clear tungsten lamps. The carbon lamps gave 1.1 foot-candles for 1.5 watts per square foot, while the tungsten lamps in the same fixtures gave 1.4 foot-candles for 0.6 watt per square foot. Fig. 2 shows a section of the dining room of the Hudson River Line steamer *Adirondack.*

Smoking rooms have a fairly high ceiling on the short run ships and a low one on the long trip class. Fig. 3 shows the arrangement employed in the smoking room of a steamship on the line of the Old Dominion Steamship Company, which illustrates the latter type of lighting. All-frosted lamps located overhead are usually used. The average illumination 3 feet above the floor was found to be 1.25 foot-candles for an energy consumption of 2.09 watts per square foot.

Fig. 3.—Smoking Room in Old Dominion Line Steamer

In passageways a low illumination is all that is needed. This is frequently obtained by small lamps located on the ceiling spaced about 10 feet apart. The average intensity is about 0.8 foot-candle.

The staterooms are generally rather poorly lighted, having but one lamp located in the center of the ceiling. Great improvement is obtained by locating this lamp over the center and one foot out from the mirror, this allowing comfortable shaving, etc., and at the same time giving good general illumination in the room. A stateroom on the Savannah Line steamer *City of Montgomery,* having a lamp at the center of the ceiling and a portable lamp near the berths, is shown in Fig. 4.

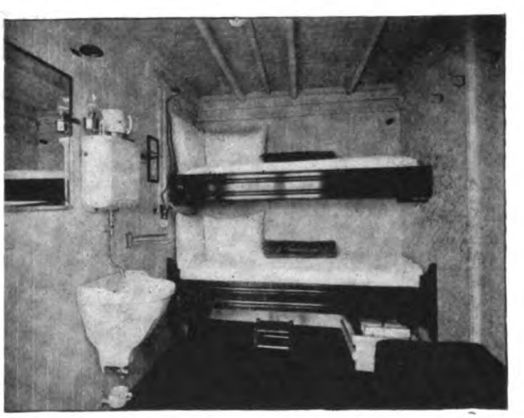

Fig. 4.—Stateroom of the *City of Montgomery,* Savannah Line

The lighting of ferries was found to be very uniform. In practically all cases the cabins were lighted by carbon lamps, in one- or two-light fixtures located on the walls over the seats. In a few cases round-ball, all-frosted lamps were in use. On the New York municipal ferry-boat *Richmond,* one hundred 60-watt high-efficiency carbon lamps were replaced lamp for lamp by 40-watt medium efficiency tungsten lamps. The former gave an average of 1.13 foot-candles, on a plane 3 feet above the floor, with an energy consumption of 1.96 watts per square

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foot, while the latter gave 3.36 foot-candles for 1.50 watts per square foot. Figs. 5 and 6 show this cabin before and after the change.

In many instances it is impracticable to change the existing wiring of a ship and, for this reason, the recommendations for a new ship would vary considerably from those

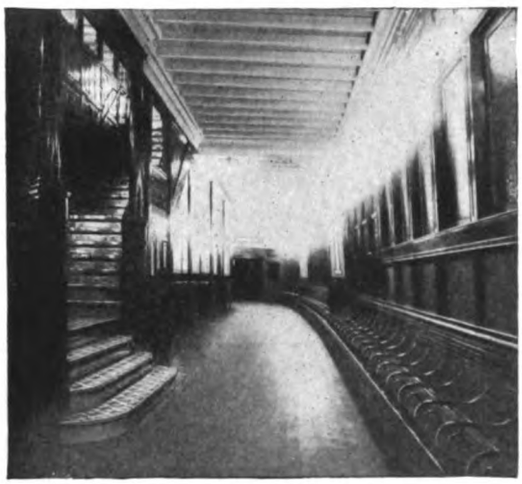

Fig. 5.—New York City Ferryboat *Richmond* Lighted with 60-Watt Carbon Lamps

for a ship at present in commission. When the wiring is already installed, the expense involved in changing the outlets may more than offset the advantages to be secured by such a rearrangement of units as will provide the most economical and effective operation. On the ships which

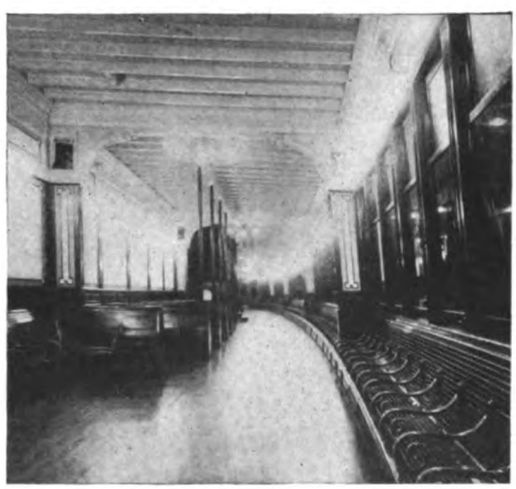

Fig. 6.—The *Richmond* Lighted With 40-Watt Mazda Lamps

have been studied it was usually apparent that a better economy, and often a more effective illuminating effect could be produced by the use of a smaller number of tungsten-filament lamps of higher candle-power, but in every case it was considered unwise to change the existing outlets. However, advantage has been taken of the higher efficiency of the tungsten-filament lamp to increase the intensity and, at the same time, reduce the lighting cost by substituting, lamp for lamp, 25- and 40-watt tungsten-filament lamps for the high wattage carbons. In some instances it was possible to also improve the diffusion by substituting frosted bulbs for clear ones.

Rapid Coal Handling Plant on the Lakes

A car dumping plant, recently erected on the Cincinnati, Hamilton & Dayton railroad dock at Toledo, Ohio, by the Wellman-Seaver-Morgan Company, Cleveland, Ohio, has established the remarkable record of unloading 340 cars of coal into lake steamships in 10 hours, making an average of 34 cars per hour. The time given includes that taken for the shifting of the boats, in order to dump the coal into different hatches. The best record for one hour was 49 cars unloaded.

The dumper is similar in design to those recently erected by the Wellman-Seaver-Morgan Company in Cleveland and Sandusky for the Pennsylvania lines, the most important change being in the use of a disappearing haulage car. This cable-propelled haulage car, instead of

New Car Dumping Plant on the Cincinnati, Hamilton & Dayton Railroad Docks at Toledo

being lowered into a pit under the inclined track, goes down into a trough under the track, as shown in the illustration, the track being raised and lowered at each end of the trough by a swinging gate. The haulage car, after pushing a loaded car on to the machine, is run back and down through the trough, coming up behind the next loaded car that has been run down on the track in front of the machine.

The use of the disappearing haulage car saves a number of employees, as compared with the former pit arrangement. With this plant the cradle that carries the car up to the pan and spout into which the fuel is dumped by turning the car over is elevated 30 feet above the water, or 5 feet higher than the elevation in most plants of this type.

This unloader has a capacity for handling cars of 100 tons capacity, the largest made.

NAVAL ARCHITECTS' ANNUAL MEETING.—The twenty-third general meeting of the Society of Naval Architects and Marine Engineers will be held in New York City on Thursday and Friday, November 18 and 19.

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Reduction Gears on the Pennsylvania

Cruising Turbines Fitted with Westinghouse Hydraulic Floating Frame Reducing Gears, Designed to Transmit 1,600 Horsepower

The general features of the machinery for the United States battleship *Pennsylvania* have been briefly discussed in the engineering press. Now that the cruising gears have been built, some additional information regarding their construction will be of more than passing interest.

The *Pennsylvania* has four shafts and propellers. Each inboard shaft is driven by a high-pressure turbine placed in the forward engine room and has an independent backing turbine located in an engine room immediately aft of the forward one. Each outboard shaft is connected to two cruising turbines, located in the forward engine room, and also to the main low-pressure turbine, with its ahead and astern elements placed in the after engine room.

At cruising speeds steam from one cruising turbine passes to the other cruising turbine, then to the main high-pressure turbine driving the inboard shaft, and finally to the main low-pressure turbine on the outboard shaft. At high speed both of the cruising turbines are disengaged and the steam enters the main high-pressure turbine and passes directly to the main low-pressure turbine.

This arrangement of propelling machinery, while adding to the number of units, has a distinct advantage in steam consumption over the earlier systems, in which the main turbines are used for cruising purposes. As about 90 percent of the total voyages of a battleship are made at cruising speed, the importance of obtaining the highest possible economy at this speed is apparent.

In order to get this better economy the two high-speed cruising turbines are connected to the outboard propeller through the medium of a two-pinion Westinghouse hydraulic floating frame reduction gear. The details of these gears are clearly shown by the end elevation, Fig. 2; the plan view, Fig. 3, and the side elevation, Fig. 4. The clutch coupling on the main gear shaft serves to disconnect the cruising turbines when the vessel is traveling at full speed.

The general construction is the same as used on all high-speed, high-power gears built by the Westinghouse Company, the distinctive feature of these gears being the use of the floating frame, which insures uniform tooth pressures under all load conditions. The practical value of the floating frame has been thoroughly demonstrated, some of the first gears built having been in continuous service over four years. The teeth of these gears, it is

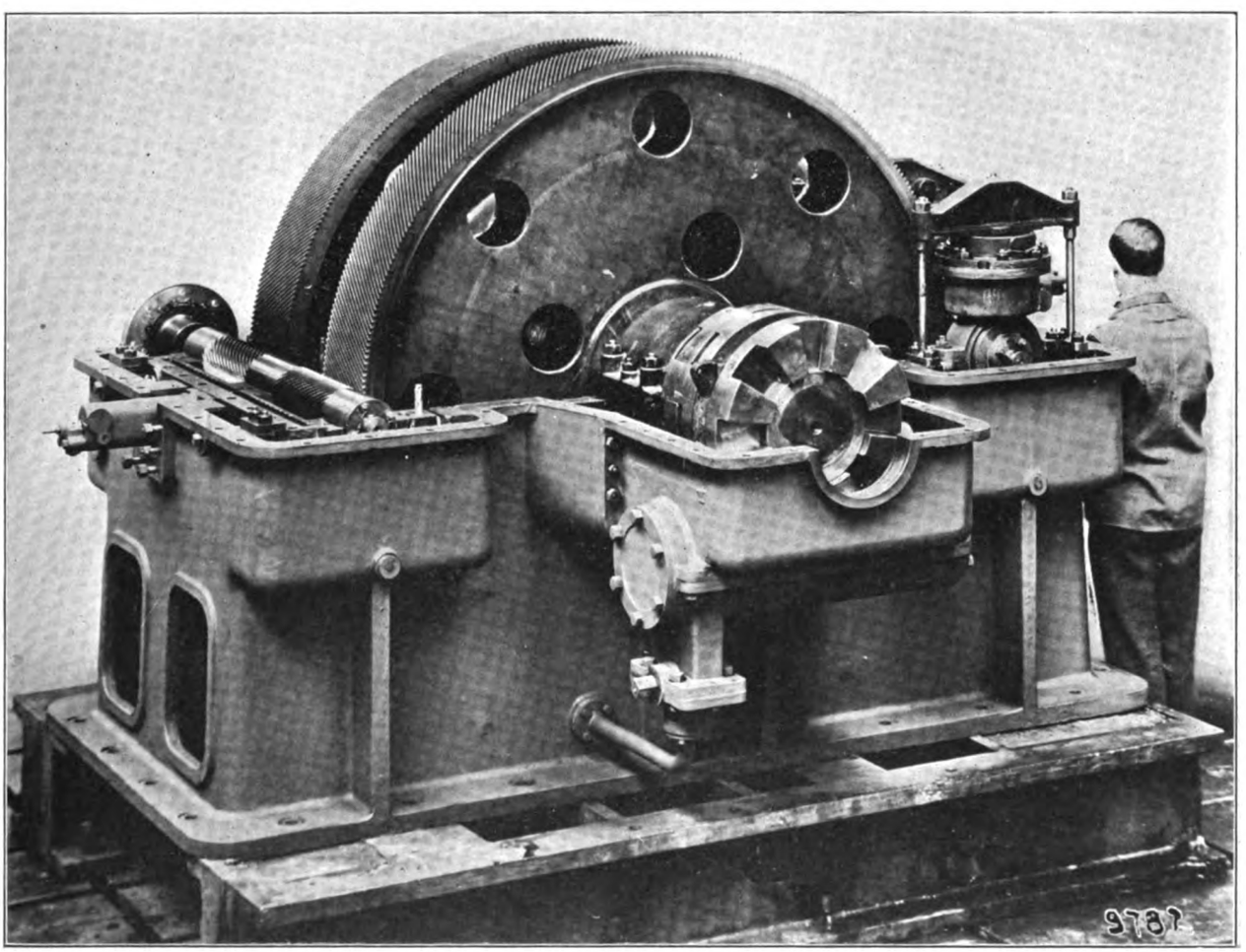

Fig. 1.—Westinghouse Reduction Gear for Cruising Turbines of Battleship *Pennsylvania*. Speed Reduction, 1,800 to 120; Horsepower Transmitted, 1,600; Weight, 23,000 Pounds

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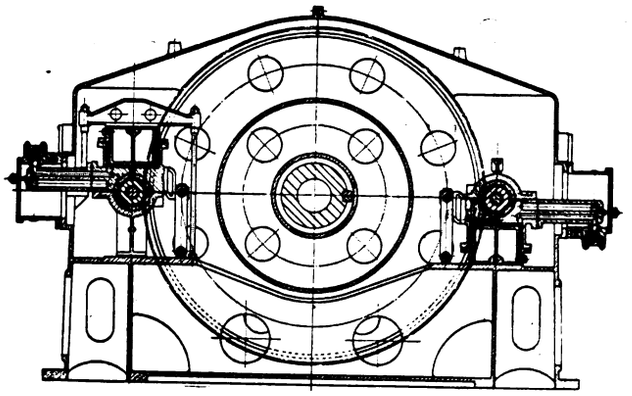

Fig. 2.—End Elevation

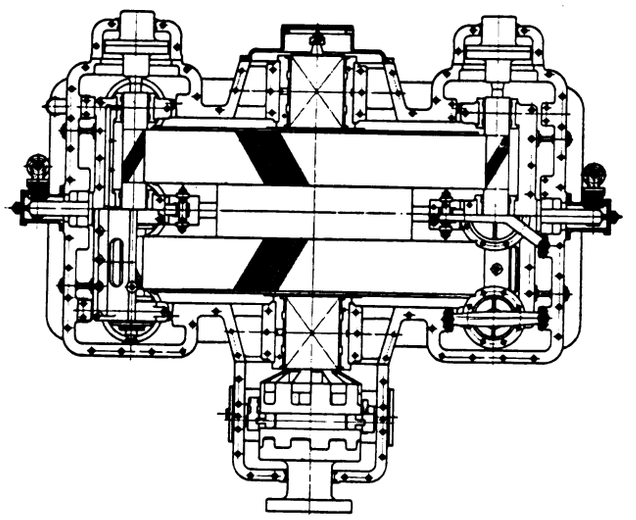

Fig. 3.—Plan

claimed, show no wear that can be detected and the uniformity of the pressure distribution is very marked, as the whole length of the gear tooth face is well polished.

An additional advantage gained by using the floating frame is the ease with which the horsepower transmitted may be determined. Experience has shown that in a high-speed bearing, such as employed here, the oil pressure developed by the bearing is directly proportional to the

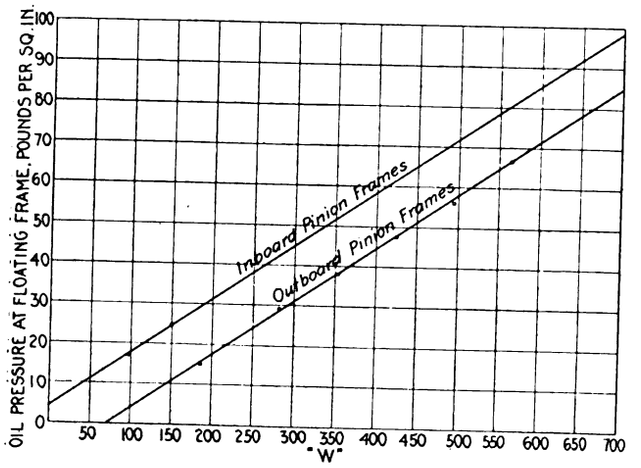

Fig. 5.—Floating Frame Calibration Curves U.S.S. *Pennsylvania* Cruising Reduction Gears. B.H.P.=$W \times$R.P.M. of Gear Wheel $\times 0.0118$

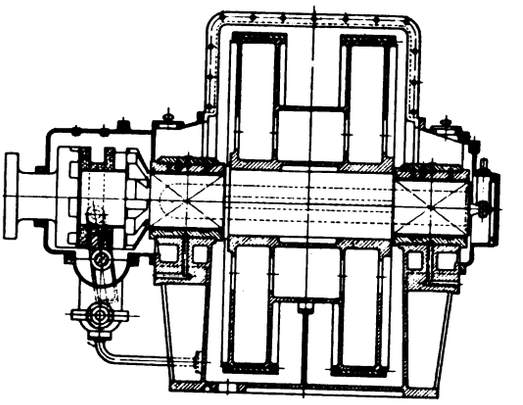

Fig. 4.—Side Elevation

power transmitted. It is only necessary, therefore, to connect the oil pipes from the floating frame to a pressure gage and obtain the speed by means of a suitable tachometer. Obviously, both of these instruments may be of the recording type, so a continuous record of the shaft horsepower developed may be obtained.

Calibration curves for these particular gears are shown by Fig. 5. The difference in oil pressures on the inboard and outboard frames is due to the fact that in one case the floating frame is above and in the other below the pinion bearings. Supposing the oil pressure on the inboard side is sixty pounds and on the outboard side forty pounds; from the calibration curves it will be seen that the corresponding values of W are 415 and 367, respectively. Multiplying the sum of these, or 782 by the revolutions per minute of gear wheel and by the constant 0.0118, the shaft horsepower is readily obtained.

The general construction of these gears and their size are clearly shown by Fig. 1. Each gear is designed to transmit sixteen hundred shaft horsepower, with a speed reduction from eighteen hundred to one hundred and twenty revolutions per minute. The weight of each gear exclusive of the clutch is twenty-three thousand pounds.

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers—V

BY F. K. RUPRECHT *

There are great advantages in using single clips double riveted instead of double clips on all oiltight work. In the case of the stringer brackets the clips can be riveted and rivets calked to the bulkheads and the horizontal flanges punched. Then these holes can be templated to the brackets, and the stringers and brackets riveted up on skids and then lifted into place in one piece. The clips for the brackets at the centerline and at the webs can be riveted and calked to the bulkhead plates before they are placed in the ship. Single clips, of course, need not be calked to bulkheads, but only the rivet points, whereas double clips must be calked as well as the rivets.

Bulkheads in the after part of the ship in the way of the shaft tunnel will be the same as the forward ones, except that the angles will be carried around the tunnel. The vertical stiffener closest to the centerline bulkhead will have to be cut and bracketed to the tunnel. The

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bracket from the lowest horizontal stiffener will in some cases have to be riveted to the tunnel by offsetting it.

In the construction of all bulkheads no stop waters, packing or red lead are to be used. Metal to metal contact will be obtained throughout, and countersunk plug-headed rivets with full points will be found the best to use.

The calking side of the centerline bulkhead should be reversed in each tank, and the transverse bulkheads should be calked on the forward side in one case and on the after side in the next. This simplifies testing to a great extent and makes the final calking a less expensive job.

Since it will be necessary to dry dock the boat while fitting the lower strakes of the bulkhead plating and other strakes of bulkhead plating. All butts and laps will be double riveted. The connection to the upper deck will be by a continuous angle, double zigzag riveted, and the connection to the tank deck may be by an angle of the same size or a flanged plate may be substituted.

Web stiffeners will be fitted to the expansion trunk bulkheads in line with those on the centerline bulkhead. These webs will be clipped to the shelf of plating at the main deck and riveted to the upper deck beams at their upper edge. If the shelf of plating has not been left at the main deck, the web plates will have to be carried down and riveted to the strong beams. The connection of the webs to the bulkheads will be through the ordinary stiffener with a double-riveted lap, and no special construction will be required. The web plate may be flanged at the outer

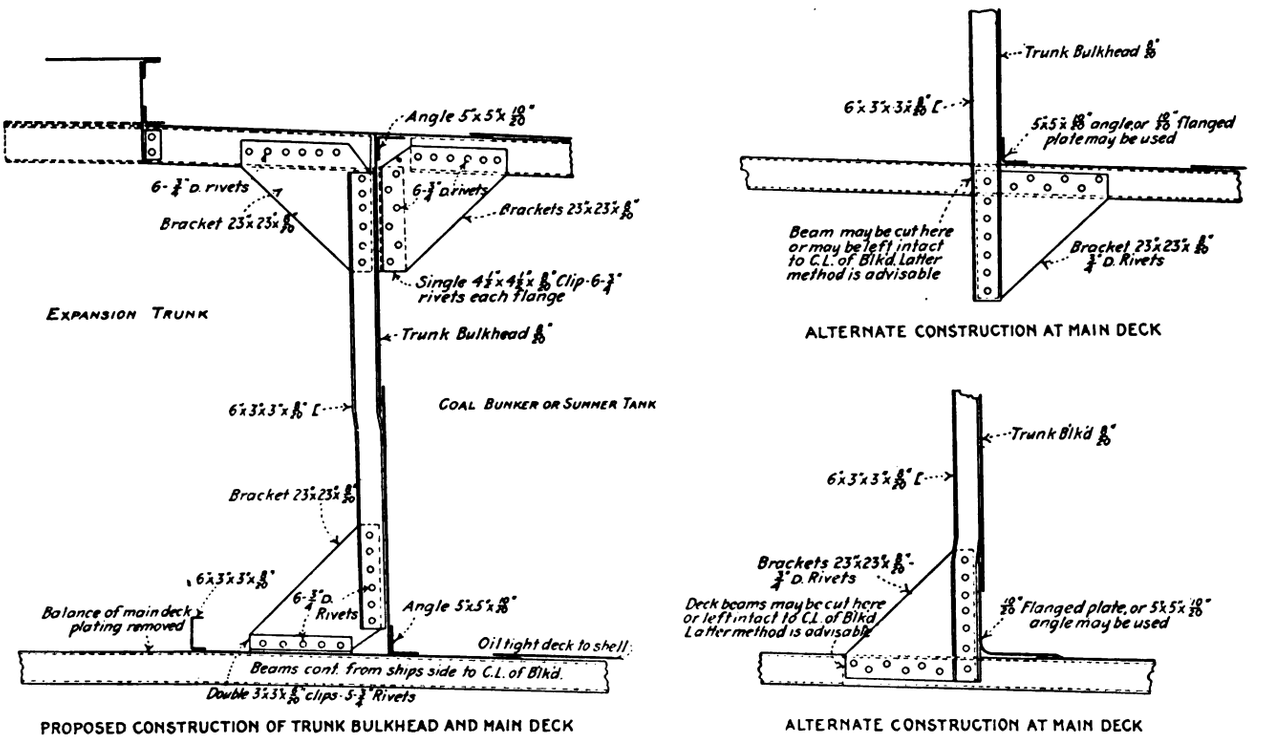
Angle 5"x5"x 10/16"
6-3/4" D. rivets
Bracket 23"x23"x 10/16"
6-3/4" D. rivets
Brackets 23"x23"x 8/16"
Single 4 1/2"x4 1/2"x 8/16" Clip-6-3/4" rivets each flange
EXPANSION TRUNK
Trunk Bulkhead 8/16"
6"x3"x3"x 8/16" L
COAL BUNKER OR SUMMER TANK
Bracket 23"x23"x 8/16"
6"x3"x3"x 8/16"
Balance of main deck plating removed
6-3/4" D. Rivets
Angle 5"x5"x 10/16"
Oil tight deck to shell
Beams cont. from ships side to C.L. of Blkd.
Double 3"x3"x 8/16" clips-5-3/4" Rivets
PROPOSED CONSTRUCTION OF TRUNK BULKHEAD AND MAIN DECK
Trunk Bulkhead 8/16"
6"x3"x3"x 8/16" L
5"x5"x 10/16" angle, or 10/16" flanged plate may be used
Beam may be cut here or may be left intact to C.L. of Blkd. Latter method is advisable
Bracket 23"x23"x 8/16"
3/4" D. Rivets
ALTERNATE CONSTRUCTION AT MAIN DECK
Trunk Blkd 8/16"
6"x3"x3"x 8/16" L
Brackets 23"x23"x 8/16"
3/4" D. Rivets
Deck beams may be cut here or left intact to C.L. of Blkd. Latter method is advisable
10/16" Flanged plate, or 5"x5"x 10/16" angle may be used
ALTERNATE CONSTRUCTION AT MAIN DECK

Fig. 16

riveting to shell, it will pay to plan the entire job very carefully so as to cut down the time spent in dry dock as much as possible.

EXPANSION TRUNKS

A few of the points in the construction of the expansion trunk bulkheads have been considered under the heading of "Decks."

The weight of plating and size of stiffeners will be taken from the classification rules. The vertical stiffeners will be placed on the inside of the bulkheads and will be bracketed at the bottom to the shelf of plating at the tank deck and at the top to the upper deck. The expansion trunk bulkheads will be continuous throughout the tanks and cofferdams, but they will be oiltight in the tanks only and in the cofferdams will have large access openings cut in them. The upper deck beams will be cut at the trunks and bracketed on both sides. The brackets will be clipped by double clips to the bulkhead in the 'tween decks, or single clips with double riveting may be substituted, and riveted to the stiffeners on the oil side (Fig. 16). The plating will usually be erected in two strakes running horizontally, and will be about the same thickness as the lower edge or may be fitted with a face angle, but flanging will be found the best.

The construction of the trunk bulkheads will be the same as elsewhere in the cofferdams, except that large openings must be arranged for access, drainage and ventilation.

The trunk bulkheads will be connected to the engine and boiler room casing to provide for a continuation of longitudinal strength. It is seldom, however, that these two bulkheads will be in line, and the methods of joining them are two. In the first the trunk bulkheads are carried at an angle from the cofferdam to casing, to which it is connected by double or triple riveted lap. In the second method the trunk bulkheads are carried straight through and are connected to the engine room and boiler room bulkheads by a large angle, and then brackets carried from these bulkheads to the casing. The former method is the less expensive and the strongest. In this case the trunk bulkheads will not be straight through the cofferdam aft of the engine room, but this is not detrimental. When trunk bulkheads pass through the cross bunker an opening must be cut in them for trimming the coal.

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If summer tanks are provided, the expansion for these will consist of a standpipe the same size as the oiltight hatch on the weather deck. In the case of a shelter deck vessel this trunk will extend through the shelter 'tween decks, but in the case of a two-deck vessel it will terminate about three feet above the upper deck—that is, the expansion trunk will consist of a high coaming hatch. The connection at the upper deck in both cases will be by a large, single angle, double zigzag riveted with furnaced corners and a similar one will be fitted at the shelter deck. In the shelter deck vessel the plating forming the trunk may be arranged in vertical or horizontal strakes, but in the case of the two-deck vessel one horizontal strake is all that is necessary. This plating will be about the same weight as the expansion bulkheads, and in the shelter deck ship small vertical angles must be fitted to stiffen the plating.

SHAFT TUNNEL

With the machinery amidships, an oiltight tunnel must be fitted for the shaft. With the engines in the stern of the vessel, of course, no tunnel is needed. No access from engine room to tunnel will be allowed, and all access will be through oiltight trunks from the uppermost deck.

The entire old tunnel will be removed and an oiltight one substituted. This new tunnel may be circular or oval in section or may have a circular top with straight sides. The circular tunnel is, in most cases, desirable owing to its strength to resist external pressure, and it should never be under six feet in diameter. The plating is best arranged in five strakes with heavy angle stiffeners on the outside. These will be in line with stiffeners on the centerline bulkhead and will be cut and bracketed to the bulkhead or stiffeners on both sides. The angles of the transverse bulkheads will be carried around the tunnel. The centerline bulkhead will be built in two sections, one under the tunnel and one above the tunnel to the tank deck level. The centerline bulkhead nor the tunnel are on the exact centerline of the ship, and therefore the bulkhead angles top and bottom will not lie on a diameter. The vertical stiffeners on the centerline bulkhead will be cut at the top of the tunnel clear of the longitudinal angles. No vertical stiffeners need be fitted under the tunnel, but flanged brackets will be double clipped, or single clipped with double riveting may be substituted, to the bulkhead and to tank top and riveted to the angle stiffener of the tunnel. The edge laps of the tunnel will be double chain riveted and the butts will have treble riveted butt straps fitted.

The tunnel will be continuous from the engine room bulkhead to the aftermost bulkhead of the aftermost cofferdam. The shaft will pass through a stuffing box into the tunnel from the engine room, but the after end of the tunnel will be open to the dry hold.

If the engine room is fitted with a thrust recess which extends into the cofferdam, provision must be made for making this recess oiltight. Usually to accomplish this in any sort of an efficient way it will have to be rebuilt and made considerably stiffer than the original recess. The thrust recess will be open to the engine room and the stuffing box will be placed at the bulkhead forming the after end of this space. The tunnel will also be riveted to this plate. The end connections of this tunnel to bulkheads will be made by heavy single angles, double zigzag riveted.

Heavy shelves for the shaft-bearing pedestals will be fitted in the tunnel where required. These will consist of a heavy boiler plate flanged and riveted to the tunnel plating. The weight will be taken by two brackets fitted under the bearer plate and clipped to the tunnel.

As mentioned above, the tunnel ends at the after dry hold and provision must be made to suspend the spare tail shaft in the rear end of the tunnel or in this dry hold. This after hold must be designed so as to permit the withdrawal of the old shaft and the installing of the new. If possible, it would be a good idea to design the access hatch to the dry hold in such a manner that the tail shaft could be hoisted to the deck. However, in most cases a plate will have to be removed from the tunnel in one of the after tanks so as to allow the withdrawal of the tail shaft. Needless to say, this method involves a great deal of expense and time.

OILTIGHT HATCHES

The oiltight hatches will be on the upper deck and there will be one for each tank. They should be arranged under, or as near under as possible, the large cargo hatches on the shelter deck, if such is fitted. If the upper deck is the weather deck, the hatches are best arranged as near to the center of each tank as convenient. In any case they ought to be kept clear of all bulkheads by at least one frame space.

The size of the hatches should be such as to allow easy access and give room to put one or more wind shutes down each hatch for clearing the tanks of gases.

A good method, and the one most commonly adopted, is to provide large hatches about 6 by 12 feet, with rounded corners and combings about one foot high. A flat bolted plate is fitted on top of the combing, and a small opening 6 by 4 feet is cut in this. This small hatch will be the oil-tight one, while the bolted cover can be used as a general cargo hatch, if desired, when oil is not carried.

The large hatches will be constructed by fitting a 3½-inch by 3½-inch by ½-inch angle to the heavy deck plates described under "Decks"; a combing plate of ½-inch steel will be riveted to the angles and carried to the bottom of the beams and clipped to them. The top angle will also be a 3½-inch by 3½-inch by ½-inch, and a ⅝-inch plate will be bolted to this top angle. Around the opening cut into this plate will be fitted a 3-inch by 6-inch bulb angle; lugs will be riveted to this to take the fly bolts. The hinged cover will be a ½-inch plate with an asbestos gasket held in place by two small angles or by a special casting. The bulb on the angle when cover is in place will form an oiltight joint with the gasket. Four slots will be cut into the edge of the cover plate to take the fly bolts and doubling plates will be fitted around the slots to prevent any deflection of the plate when bolting down. Two fly bolts will be fitted on each side of the hatch, and by unscrewing those on one side and slacking the ones on the other the cover will swing back as if on a hinge. The large plates will be bolted down oiltight to the coaming angles by ¾-inch closely spaced bolts. Lamp wicks soaked in red lead will insure a tight joint and will prevent corrosion. Since these hatches will be raised very seldom, we must make some provision against this action. A sketch of hatches is shown in Fig. 17.

An ullage plug 6 inches in diameter will be fitted in the center of each hatch. This will be a brass screw plug that is removed to take the density and temperature of the oil every day during the voyage.

Lifting rings must be provided so that the large hatches can be removed when desired. If the flat top has been stiffened by angles on the outside, slots may be cut into these angles to take a block and tackle.

In some cases it may be found advantageous to fit a continuous hatchway about 6 to 8 feet broad and 2 feet

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high with the small oiltight hatches on top to each tank. In this case the transverse and longitudinal bulkheads must be carried up to the top of this trunk. The upper deck is then only fitted to the side of this trunk.

In the case of side summer tanks the hatches will be fitted in the same manner, but the large bolted plates will be made about 6 feet by 8 feet with 4-foot by 4-foot fly-bolt hatches located on top. Lifting rings and ullage arrangements must be made to fit stanchions and chains around these manholes when open.

Arrangements must be made to give access to the dry holds. The forward one can, as a rule, be reached from the hatches to the chain locker. The after one should have a hatch with a trunk way carried through the 'tween decks.

Ladders must be provided for access to all oil tanks,

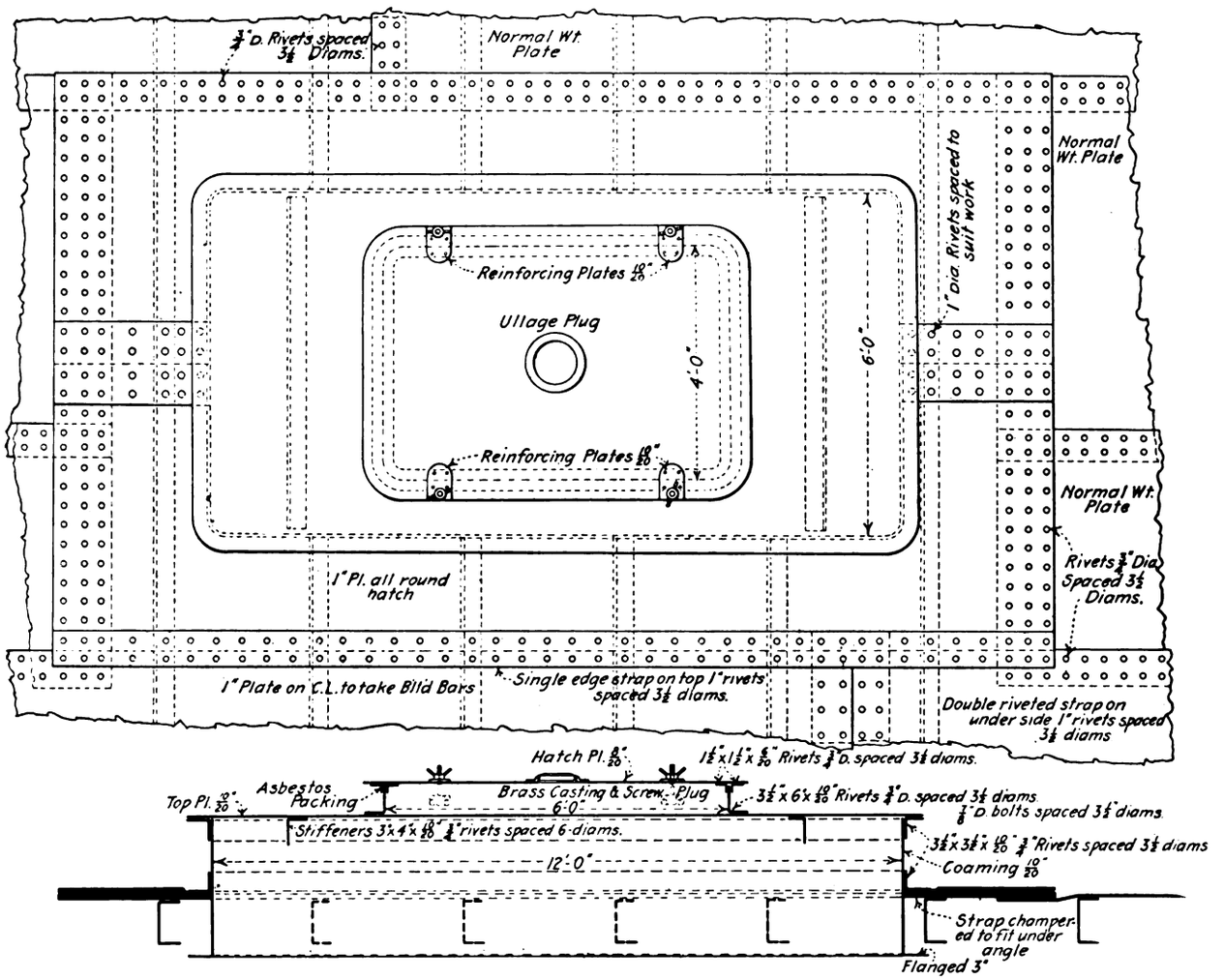

Fig. 17.—Oiltight Hatch

plugs will be fitted in the same manner as on the other hatches.

If the 'tween decks are used for coal or cargo, 6-foot by 12-foot hatches of the ordinary construction will be fitted with their wooden covers and tarpaulins. If the vessel is of the shelter deck type, corresponding hatches must be fitted on this deck. The number of these will depend upon the subdivision of the 'tween deck, but four on each side will be the usual number.

The cofferdams will also have oiltight hatches on the upper deck on each side of the centerline bulkhead. These will usually be oval manholes about 23 inches by 15 inches, although if considered desirable larger hatches may be fitted. These manholes may be of the hinged type with butterfly bolts or of the bolted plate type. The latter is, of course, cheaper, and would answer the purpose almost as well as the more expensive one. A low combing or a high combing may be used, but if the low type is used, cofferdams and pump rooms. These should be arranged as safely as possible and should not be fitted in one continuous length except in the cofferdams. In the pump rooms these ladders should be of the engine or stoke room type.

(To be concluded.)

UNITED STATES EXPORT COAL TRADE.—The larger part of the export coal trade of the United States has been with other countries of the Western Hemisphere. Canada absorbs practically all of the anthracite that finds foreign purchasers and is also an important buyer of American bituminous fuel, while the republics to the south take most of the remainder of the "soft" coal. In the seven-month period ending January, 1915, anthracite shipments were but 135,986 tons, or 6 percent less than in the corresponding period of 1913-1914, whereas bituminous exports fell off 2,193,731 tons, or 20 percent.

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The Red Star Liner Belgenland

Triple Screw Passenger Steamer of 33,000 Tons Displacement Launched by Harland & Wolff, Belfast

An interesting commentary on the present European war occurred, appropriately enough, on the last day of the year 1914 in the launch of a large new passenger steamer by Messrs. Harland & Wolff, Ltd., of Belfast. The name of this boat is the *Belgenland* and her port of registry is Antwerp, which indicates that some hope is entertained for the restoration of Antwerp to its former position in the commerce between Europe and America.

The *Belgenland* is a triple screw passenger steamer about 700 feet long and 78 feet beam, with a gross tonnage of approximately 27,000 tons and 33,000 tons displacement. She has been constructed on the latest and most approved principle, the double bottom extending right fore and aft and the watertight bulkheads carried up to the awning deck. There are seven steel decks besides the orlop deck and the bridge deck. Accommodation is provided for 660 first class, 350 second class and over 2,000 third class passengers, the first class accommodation including a number of cabines-de-luxe on the bridge deck. In addition to the usual first class dining saloon and reception room, reading and writing room, lounge and smoke room, will be a children's saloon, room for maids and valets, gymnasium and children's playroom, greenhouse, verandah, swimming bath and electric baths. The second class accommodation, which is also of a superior nature, will include a gymnasium.

Auxiliary Machinery

The appliances for working the ship and cargo will be of the latest type, the steering gear being of Harland & Wolff design, and the steam winches, windlass and capstan are very powerful, efficient and up to date. There will be a large refrigerating machinery plant. There is a large and very complete electrical installation consisting of four main steam-driven engines and dynamos having a combined output of 1,200 kilowatts and one 75 kilowatt auxiliary Diesel oil engine set. This latter is situated well above the waterline so that in case of emergency it can supply lighting throughout the ship, wireless telegraphy, boat winches, and also operate the electrically controlled watertight doors should the four main sets for any reason be put out of action.

In addition to the lighting, which will consist of about 4,500 25-candlepower lamps, the cabins are electrically heated and there is a complete system of warm air ventilation and suction fans, the control for all of which is grouped together at a central point, enabling the air to be kept fresh and the temperature normal at all seasons. Among other electrical apparatus, there are passenger elevators for convenience in getting from one deck to another, and also electrically operated hoists in connection with the stores. The boat winches are also electrically operated and there are in addition a number of service machines in the galleys, bakeries, etc.

The propelling machinery of the *Belgenland* consists of two sets of reciprocating engines driving the wing propellers, and one low-pressure turbine driving the center propeller. The reciprocating engines are of the inverted, direct-acting, four-crank, triple expansion type, balanced on the Yarrow, Schlick & Tweedy system, having four inverted direct-acting cylinders, 35½ inches, 56 inches, 64 inches, and 64 inches diameter by 5-foot stroke, designed for a working pressure of 215 pounds per square inch. The turbine is of the Parsons reaction type and designed to operate in the ahead direction only, by exhaust steam from the reciprocating engines.

Details of Main Engines

The design generally is that adopted by Harland & Wolff, Ltd., and in construction the machinery embodies the builders' chief features and high class character. All the cylinders are independent castings of high grade cast iron with liners fitted to all of them, the bottoms of the cylinders being double, and strongly ribbed and arranged with loose boxes for carrying the metallic packing which is fitted for the piston rods and valve spindles. The cylinders and casing covers are of cast iron, box section, arranged to take escape valves, lubrication, etc. The columns supporting the cylinders are of cast iron, rectangular in section and firmly bolted to sole plates and all cylinders, the tops being securely connected together with tie bars. Loose guide plates are fitted to both front and back (the former being for the ahead motion) and both arranged for water circulation through them in order to carry away the heat which will be produced. The sole plate is of strong cast iron, box section, having nine half round recesses for shaft bushes arranged to take the crankshaft, which is built in four pieces with the angles arranged to suit the balancing of the engines.

The high-pressure pistons are of cast iron, the intermediate-pressure and low-pressure of cast steel of conical shape, the weights of which have all been arranged to suit the balancing of the engine. The piston packing is of the Ramsbottom type for high-pressure and intermediate-pressure, and Lockwood & Carlisle for low-pressure, the junk rings being made specially deep for guidance, as no tail rods are fitted; all the cylinders are fitted with piston valves of hard, sound cast iron. The high-pressure and intermediate-pressure cylinders are arranged for steam to enter between the valves, the top piston in each case being larger in diameter than the bottom one to balance the weight of the valve and gear, while, in order to carry the weight of the low-pressure valve (which takes steam on the outside) and gear, balance cylinders are fitted.

The reversing is effected by two of Brown's steam and hydraulic type engines, each with a hand pump for pumping into the hydraulic cylinder when reversing by hand is required. The engines are arranged at the side of the high-pressure front columns with a hand pump in a convenient position. Attached to the sole plate of each engine is a turning engine, which turns the engine and shafting through worm wheel gearing, which latter can also be worked by hand. The governors are of Aspinall's type driven by lever from the high-pressure main engine crosshead and operate a small steam and hydraulic engine for working the throttle valve, means being provided for disconnecting the couplings and operating the engine by hand lever. An emergency governor is also fitted in connection with the main reversing engine, the reversing links being thrown into mid position when this emergency governor comes into action.

The low-pressure turbine, which is direct coupled to its line of shafting, has been designed as a compromise be-

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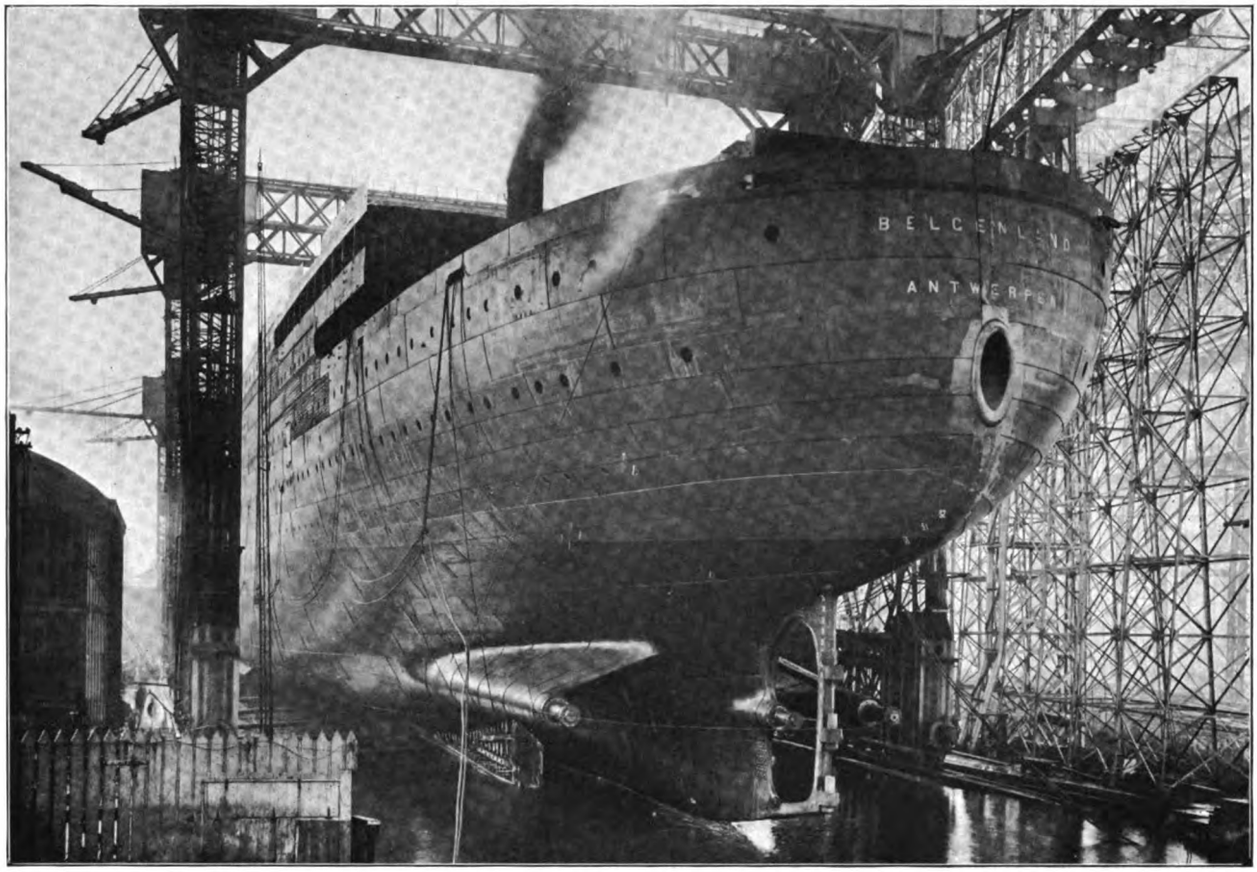

Stern View of the Steamship *Belgenland* on the Building Ways at the Harland & Wolff Yard, Belfast. Length, 700 Feet; Beam, 78 Feet; Gross Tonnage, 27,000; Displacement, 33,000; Motive Power, Combination Reciprocating Engines and Low Pressure Parsons Turbine

The *Belgenland* Just After Launching

tween the propeller and turbine efficiencies and the weight, which is, of course, the usual procedure in marine practice. The turbine cylinder, bearing blocks and bushes are of cast iron, the latter being lined with white metal and arranged for forced lubrication. The rotor drum is of steel, hollow forged, the wheels of cast steel and the spindles of forged steel. The turbine is arranged with a dummy of such diameter that the steam thrust approximately balances the thrust of the propeller, but a thrust block is also provided at the forward end of the forward bearing block, having phosphor bronze rings fitted into steel carrying blocks. The blading is of brass of Parsons standard section.

Between the reciprocating engines and the low-pressure turbine change valves are fitted, so arranged that when maneuvering the exhaust steam from the reciprocating engines passes direct to the condensers without going through the turbine. The valves are of the balanced piston type fitted with Ramsbottom rings and worked by direct acting steam and hydraulic engnines operated from the starting platform. Electric power has been utilized for the lifting of the heavier parts of the machinery, and also for the turning of the turbine rotor and its line of shafting. A governor of the Proell type is fitted to the turbine and is arranged to operate the change valve engines, so that steam is shut off the turbine should the speed of the rotor become excessive.

The thrust of each propeller is transmitted by means of

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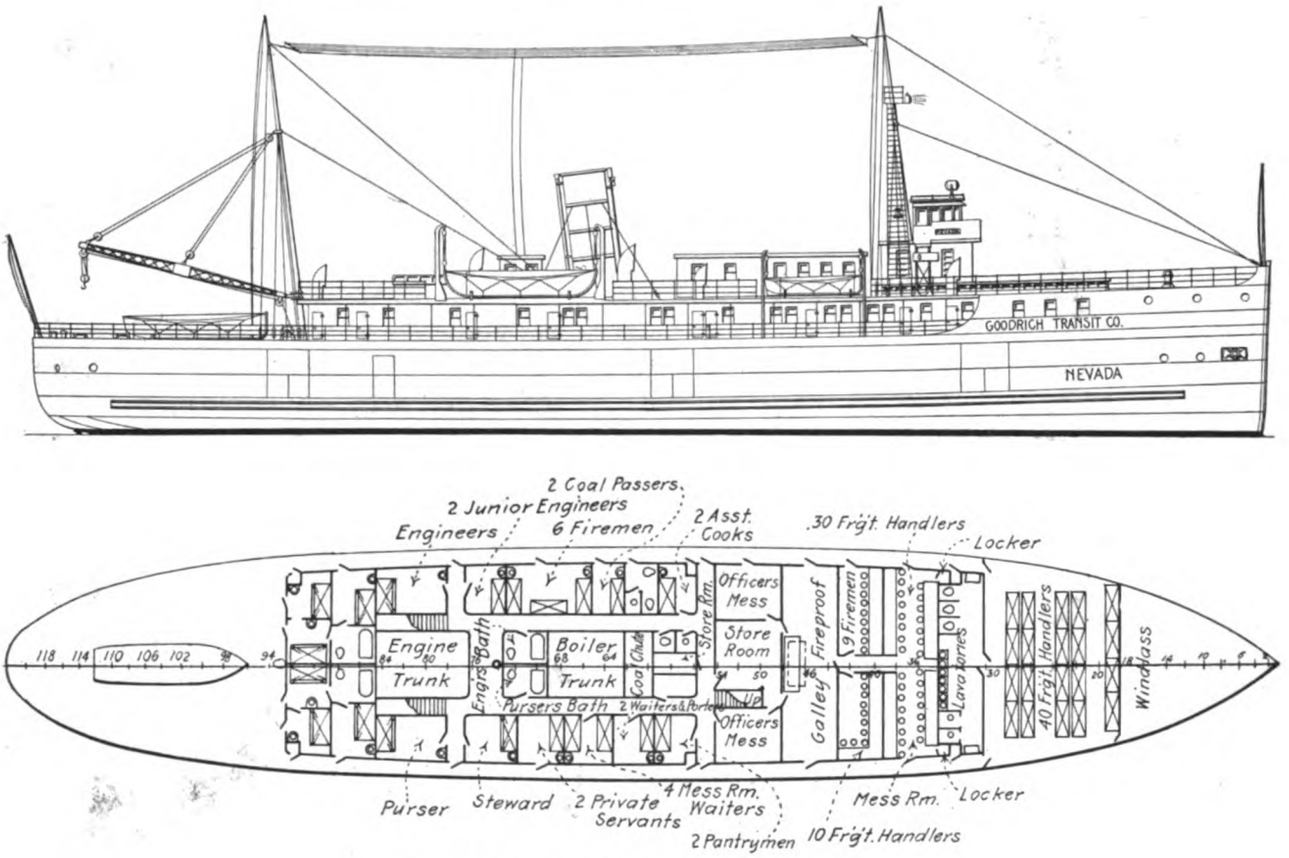

Fig. 1.—Profile and Deck Plan of Steamer *Nevada*

collars forged on to the thrust shaft to the thrust block, and is taken up on cast iron shoes lined with white metal on both sides, the weight of the thrust shaft being carried by two bearings, one at each end of the thrust block. All the shafting throughout the ship is of Siemens-Martin ingot steel, made by Messrs. John Brown & Co., Ltd., Sheffield, the plummer blocks for carrying the same being lined with white metal of Harland & Wolff's best quality, while the propeller shafts are fitted throughout the stern tube with a gun-metal liner in one piece. The whole of the shafting is considerably in excess, as regards strength, of that required by the Board of Trade or Lloyd's rules. The stern tubes are of cast iron fixed into stern frame and stern post by wrought iron nuts outside, and bolted with a flange to the bulkhead on the inside. Gun-metal bushes lined with lignum vitæ are fitted to the stern tubes, the inner end of the forward bush being arranged with a stuffing box and gland.

The wing propellers are fitted with three loose manganese bronze blades, each on a cast steel boss, the blades being secured to the boss with steel studs and forged bronze cap nuts. The turbine propeller is of solid turbadium alloy. On the aft end of each boss cast iron cones are fitted over the propeller shaft nuts.

Engine Room Auxiliaries

The condensers are pear-shaped, built of mild steel plates with cast iron water boxes, and are arranged with the steam branches the full length of the tube. They are also arranged so that the inlet circulating water enters the bottom and leaves at the top, the water being circulated by centrifugal pumps of the builders' own make, and of ample capacity for obtaining 28-inch vacuum on service. The condensate and air which enters the condensers are extracted by two independent pumps of Weir's dual type. These pumps deliver the water to two large feed tanks alongside, one on each side of the ship, each of which is capable of holding a ten-minutes' supply of feed water when the engines are running at full power. The feed water gravitates from the tanks to the control tanks on the hotwell pumps, passing through filters on its way, the two twin feed water filters being of Carruthers' make, arranged in pairs so that one can be cleaned while the other is in use. Two pairs of Weir's main feed pumps are fitted, of ample capacity, each being capable of dealing with the whole of the feed water at low speed, and discharging the same through a feed heater of Weir's make to the boilers.

In addition to the above auxiliaries, there are two sanitary, two bilge and three ballast pumps, all by Harland & Wolff and all of the duplex type. For dealing with the heating and cooking returns, a separate heater is fitted, circulated by the hotwell pump of Weir's make, while the condensation is drawn away by means of one of Weir's "Mono" type air pumps. For port use an auxiliary condenser of Harland & Wolff's pear-shaped make is fitted, circulated by a steam-driven centrifugal pump of Harland & Wolff's make. The air pump in connection with this auxiliary condenser is of Weir's "Mono" type. For feeding the boilers in port, one single cylinder pump of Weir's make is fitted in the engine room, and one pump of Harland & Wolff's make in the the compartment at the forward end of the boilers; while in addition a general service donkey pump of Harland & Wolff's duplex type is also arranged in the engine room.

In the engine room two fresh water distillers of Hocking's make for ship's use, and two evaporators of Weir's make are fitted, while for pumping the fresh water to the

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deck two of Weir's single cylinder pumps of ample capacity are fitted. For the forced lubrication to the turbine bearings, two single cylinder double acting pumps of Weir's make are fitted, each pump being capable of dealing with the full quantity of oil required, while the other is a standby. These pumps draw from the drain tanks below the floor level and discharge through a cooler to the supply tank in the engine casing. For the forced lubrication of the center and wing shaft tunnel bearings, and also the wing thrust blocks and bearings, one single cylinder pump of Weir's make is fitted to draw from the drain tank and discharge to the plummer block supply tank. There are also arranged in the special electric engine room four electric engines of Allen's make, and a refrigerator with three pumps by Messrs. J. & H. Hall, Ltd.

The machinery spaces are well ventilated, eight 40-inch Sirocco fans being fitted for ventilating the boiler rooms with cross connections and suitable trunks led down to within 7 feet of the stokehold floor, while the engine room, in addition to natural ventilation, is fitted with two 45-inch Sirocco fans, these fans being electrically driven.

There are ten double-ended boilers 15 feet 9 inches diameter by 20 feet long, each with six Morison furnaces, the opposite furnaces being led into a common combustion chamber. The boilers have been constructed in accordance with the rules of the Board of Trade for a working pressure of 215 pounds per square inch, and are arranged to work with natural draft. Four patent hydraulic ash expellers are fitted in the boiler room.

It will be seen from the above that the *Belgenland* is finely equipped both from the passenger carrying and the engineering point of view, and it is to be hoped that at the completion of the construction the position of international affairs will be such as to give this new vessel her proper place in the important fleet which plies between the old world and the new.

Freight Steamer Nevada

The Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., has begun work on a new freight steamer for the Goodrich Transit Company, Chicago, Ill. This vessel, which will be named the *Nevada*, following the custom of the Goodrich Line in naming its boats after States whose names end in an "a," will be 230 feet long over all, 212 feet 9 inches long on keel, 42 feet molded beam, 18 feet molded depth to main deck and 29 feet molded depth to spar deck.

The *Nevada* is built for the winter trade on Lake Michigan and has been specially designed to withstand

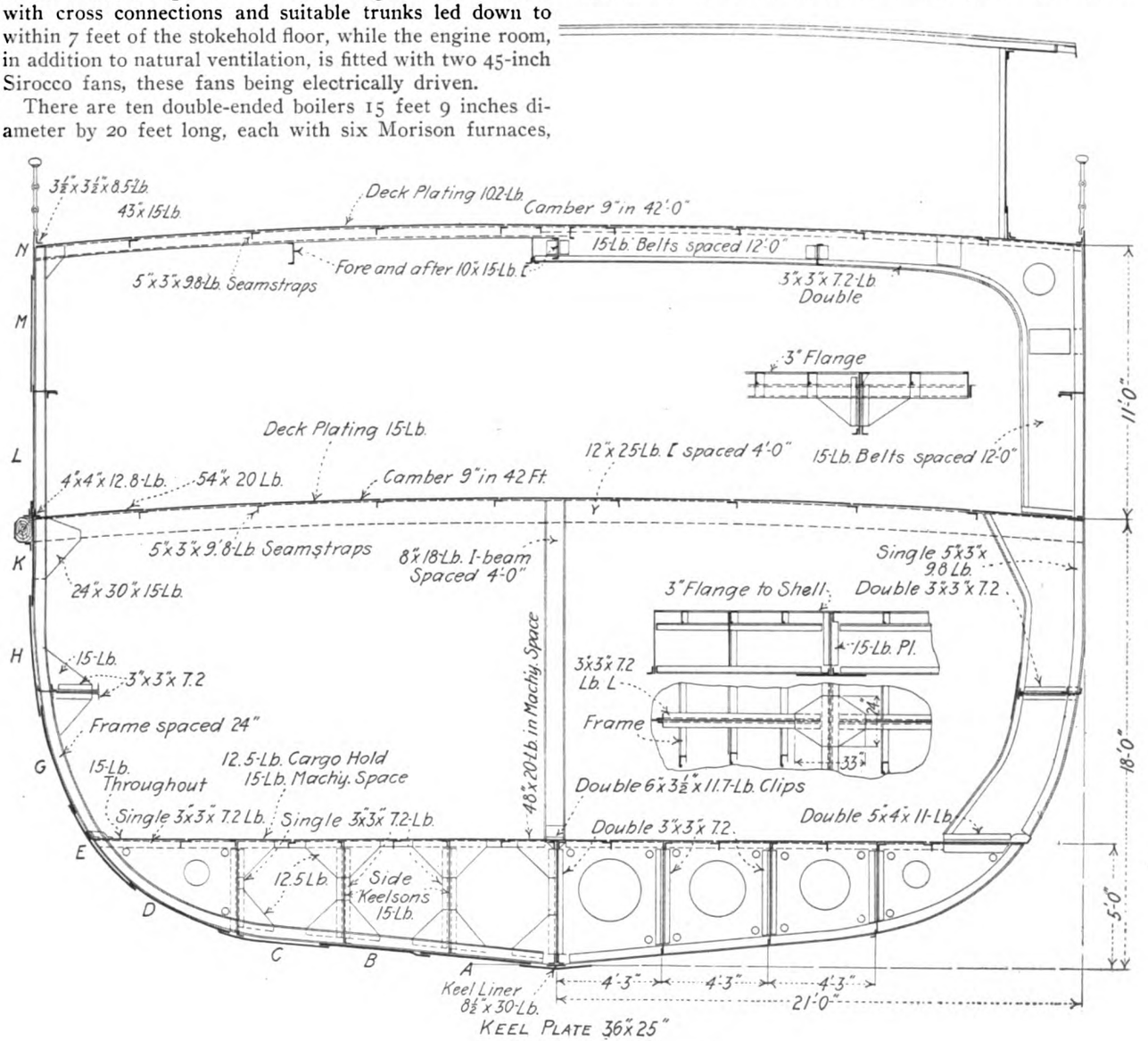

Fig. 2.—Midship Section of the *Nevada*

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service in icebound waters, rather than to conform to any special rules. The main frames will be 6-inch bulb angles spaced 24 inches, with close spacing fore and aft. Thirty-inch belts of plate will be spaced about every 10 feet. There will be a 6-inch by 1-inch waterline strake all fore and aft, to avoid any corrugations from ice pressure. All bow plating will be ¾ inch or 1 inch thick.

Just below the waterline a 30-inch plate stringer will be fitted, and throughout the ship there will be a double bottom five feet deep. The hull is further subdivided into seven watertight compartments by transverse bulkheads. There will also be an orlop deck in the fore hold to give additional stiffness.

The spar deck will be supported by arch beams spaced 12 feet, there being no stanchions between the main and spar decks. The head room of 11 feet between decks will give plenty of height for freight, keeping clear of all piping, wiring, etc. There will be three large freight gangways and one supply gangway on each side of the ship. The forward gangway on each side will be 9 feet wide by 9 feet high to accommodate large trucks, etc. Three hydraulic freight elevators will be installed, one in each hold.

In addition to the steam fire extinguisher required by law, all freight space in the ship will be served by a sprinkling system. The vessel is so constructed that each freight hold can be completely shut off, so that in case of fire the damage will be limited to a small space. When the gangways are shut all openings through the spar deck can be securely locked, so that no one can gain access to the freight. Ventilation is provided for the main deck by six large ventilators running up through the cabin above.

Accommodations for a crew of seventy-five will be provided on the spar and upper decks. There will be separate wash rooms and mess rooms for all the different departments of the crew. Six rooms with two baths will also be provided on the spar deck for representatives of the owners, as well as a large room and private bath on the upper deck. The captain's and mates' quarters are on the upper deck directly below the pilot house. The wireless room is in a separate cabin on the upper deck aft.

The life-saving equipment includes two 50-person lifeboats and one 25-person life raft. A large launch will also be carried. This equipment, together with the life preservers, etc., will be in excess of the requirements of the new seamen's bill.

Propulsion is by a triple-expansion engine with cylinders 21½, 34½ and 56 inches diameter by 36 inches stroke, designed to develop 1,600 horsepower with a boiler pressure of 185 pounds per square inch, giving the vessel a speed of 17 miles per hour. The boilers are of the Scotch type, two in number, each 13 feet 3 inches diameter by 11 feet long, with three 40-inch furnaces in each.

The auxiliaries include extra large fire pumps, so that the vessel will be able to do excellent work as a fire boat. A boom 40 feet long with a capacity of 5 tons is fitted on the after side of the main mast for handling freight, and a three-drum hoisting engine will be installed for operating this boom. Freight that cannot be handled through the main gangway will be carried on the spar deck aft, which has been especially designed with this purpose in mind. In addition to handling heavy freight, the cargo boom will also be useful in case it is necessary to use the boat for wrecking purposes.

For mooring the vessel a two-drum mooring machine is fitted both forward and aft. A large towing bit, with the necessary chocks, will also be installed, so that the *Nevada* can come to the assistance of any other ship of the fleet that may be in trouble. All the latest safety devices will be installed and the vessel will be as safe as it is possible to make her. The fire danger has been especially guarded against.

The *Nevada* will be ready for service early in the fall and will be an innovation in vessels of this class.

Use of Oil Engines as Auxiliary Power for Sailing Vessels

Although oil engines were brought into use in the marine field about twenty-five years ago, it is only recently that they have begun to play an important part in the shipping trade, where steam has been the dominant power. Now that oil engines of large size are produced, which give a good account of themselves as far as reliability and economy are concerned, this form of power has made considerable headway in the field of auxiliary sailing vessels, and the prospects for the revival of sailing vessels in regular trade routes are very favorable.

The principal advantages possessed by auxiliary sailing vessels, as compared with sailing vessels without power, are that the vessel is able, irrespective of weather and winds, to make her voyage within a fixed time, which enables her owners to obtain better freight rates. All towing charges are dispensed with and time is gained when handling the cargo by means of the power available for winches and booms. Greater safety is also assured for the ship in all weather and in dangerous waters. Under the present favorable conditions in the freight market, ship owners have seized upon the opportunity to press into service comparatively obsolete sailing vessels by installing in them heavy oil engines as auxiliary power, and cases are on record where the whole equipment of auxiliary machinery has been paid for by the profits of a single voyage.

A case in point is the fitting of the four-masted steel bark *Fingal*, owned by the Trans-Atlantic Motor Ship Company, Christiania, Norway, with two Bolinders engines, each of 160 brake horsepower. The *Fingal* is a ship of 2,435 tons net, and, as a sailing ship, has a large spread of canvas. The twin-screw arrangement of auxiliary machinery, aggregating 320 horsepower, was installed in four days, and the vessel, with 1,500 tons of ballast, was taken out on a trial trip on June 8, developing a speed of 7.5 knots against a moderate breeze without sailing power.

On this ship the engines occupy a comparatively small space, only about 3 to 4 percent of the ship. Fuel oil tanks are provided of sufficient capacity to supply the ship for a continuous voyage of 40 days. The fuel consumption for both engines is 1.5 tons per day of twenty-four hours at normal load.

As compared with a freight steamer, the auxiliary sailing vessel has shown favorable results. The average speed in both cases has proved to be about the same, the loading capacity is in favor of the sailing ship, the weight and space of the oil engine equipment being considerably less than that of the machinery equipment on a steam vessel. The initial and running costs and depreciation are also less and, when the vessel is idle, there are no standby losses or repairs to tanks, boilers, floor plates, firemen's wages, etc.

Recent installations of oil engines on sailing vessels have shown that, as compared with sailing ships without auxiliary power, profits in transporting freight have increased by about 50 percent or more.

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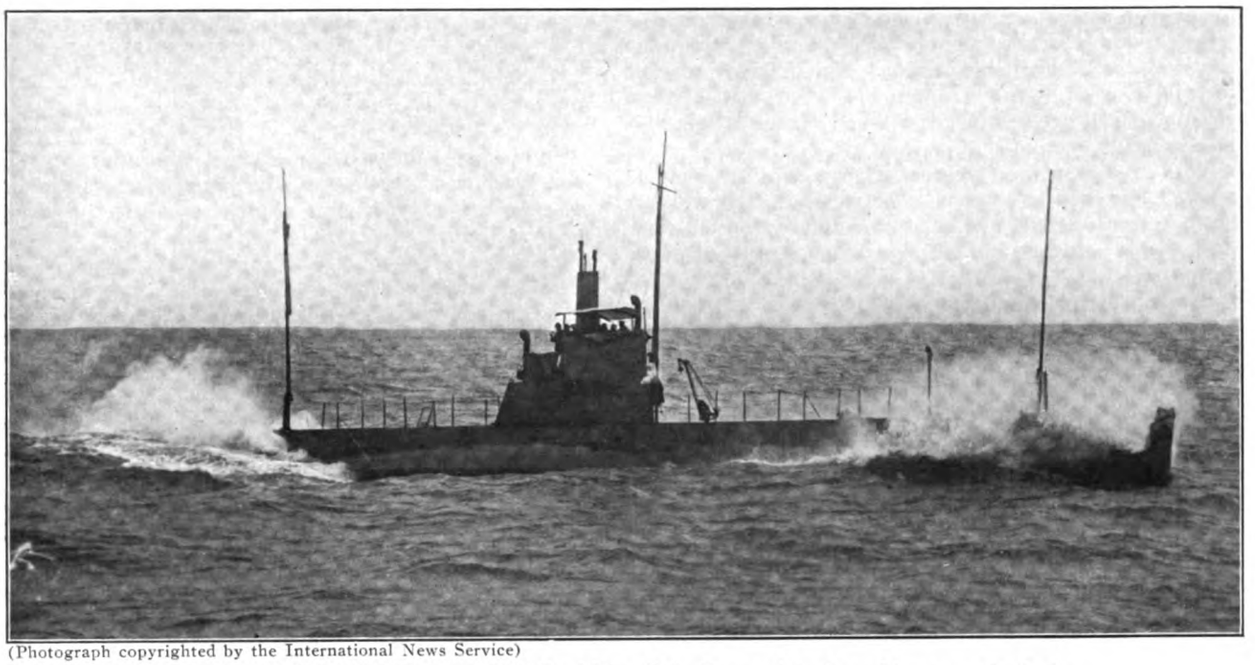

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Fig. 16.—Modern U.S. Submarine of Holland Type Fully Equipped for Long Voyage on the Surface

Modern Submarines in War and Peace—II

Development of the Submarine Beginning with 1893—Principles of Construction and Operation

BY SIMON LAKE *

When in 1893 the United States Congress appropriated $200,000 (£41,000) for a submarine boat and the Navy Department advertised for inventors to submit designs for such vessels, it was for the first time officially recognized that there *might* be possibilities in this type of boat. Most of the naval officers, however, were very skeptical of the practicability of such craft, and from the conservative point of view they were perhaps justified, as no satisfactory boat had up to that time been built.

A programme of requirements, which undoubtedly would produce a weapon valuable for defense, was made up by the Navy Department, and these requirements were designated in the following order of importance:

1. Safety.
2. Facility and certainty of action when submerged.
3. Speed when running on the surface.
4. Speed when submerged.
5. Endurance, both submerged and on the surface.
6. Offensive power.
7. Stability.
8. Visibility of object to be attacked.

This standard of accomplishments is as important today as when it was first promulgated.

This first appropriation was brought about by a recommendation to Congress, made by Commander Folger, Chief of Ordnance, who had been much impressed with the possibilities of submarines after witnessing a test of the Baker boat in Lake Michigan. Commander G. A. Converse, president of the Torpedo Board, also made a report certifying that it was his belief that a larger vessel operating on the Baker principles would, with some modifications, prove valuable for defensive and offensive purposes.

France at this time was the only other country that was giving official encouragement to the development of the submarine. She was conducting experiments with the *Gymnote*, a small vessel of the diving type, and had under construction a much larger vessel to be operated on the same principle. This vessel was afterwards called the *Gustave Zede*, but she did not go into commission for some time, as her submerged control was found to be bad. One report of her performance states that "with the committee of engineers on board, her performance, in attempting to keep an even depth line was most erratic and frequently a 30-degree inclination was reached before the boat could be brought up. On one occasion she hit the bottom in 10 fathoms with sufficient force to unseat the engineering experts."

The *Gymnote* was 5 feet 10 inches diameter amidships and 59 feet 10 inches in length. The *Gustave Zede* was 10 feet 9 inches diameter and 148 feet long. It is very difficult to secure sufficient metacentric height in a boat of the above proportions, which probably accounted largely for their erratic behavior submerged.

In response to the United States Government's advertisement for designs of submarine boats, only three inventors submitted plans and specifications. They were Mr. George C. Baker, Mr. J. P. Holland and the author. Mr. Baker submitted designs of a boat 60 feet in length and of about 120 tons displacement. This vessel was expected to have a speed of about 8 miles per hour. The

* Member of Institution of Naval Architects (England), Schiffbautechnische Gesellshaft (Germany), Society of Naval Architects and Marine Engineers (United States) and American Society of Mechanical Engineers.

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method of submerged control and known characteristics were the same as have already been described in connection with his boat as built in 1892. Mr. Holland proposed to build a vessel 85 feet in length, 11½ feet diameter and 168 tons submerged displacement and 154 tons light displacement.

This gave a surface "reserve of buoyancy" of only 14 tons, or less than 10 percent. The method of control was by the use of vertical and horizontal rudders on the same principle as was used in his *Fenian Ram,* described in the July issue.

In 1897 Mr. Holland published in *Cassier's Magazine* an article on submarine navigation which gives some of his experiences with the *Fenian Ram.* This article very well explains the state of the art of submarine navigation in 1893. One of the early difficulties encountered was to know the direction one was going when submerged. Referring to his experience in the *Fenian Ram,* Mr. Holland said:

"Experience with submarine boats had been so very limited up to 1881 that more difficulty in steering a straight course by compass while submerged than while moving on the surface was scarcely expected. The writer had no suspicion that his boat could not be steered perfectly until he tried it after making about half a dozen preliminary dives to adjust the automatic apparatus. Having become doubtful of the reliability of the compass, he had it carefully compensated, and then made a trial submerged run in New York harbor, heading the vessel towards a point which he knew was about twelve minutes' run distant.

"The boat dived at an inclination of about 15 degrees, and it was noticed that when she again reached a horizontal position the compass needle swung around a complete circle and vibrated a good deal before coming to rest. The boat was then discovered to be about 90 degrees off her course. It was steered again in the proper direction, and then inclined upward at a sharp angle to find whether the action of the compass would be as erratic while rising as while running downward. One end of the needle dipped to the bottom of the cup when beginning the ascent, and remained there during the rise. When the boat approached a horizontal position, a few feet below the surface the needle swung around as violently as it had done during the boat's descent, and then came to rest again at a point that indicated the boat to be far off the true course.

"As it appeared quite clear that the run was not made in the direction intended, and that about one mile must have been covered from the start, ten minutes having already passed, the boat was brought to the surface of the water just in time to prevent her from running on rocks that lay about twenty yards straight ahead and sixty yards down from the starting point.

"The boat had been started to run over one mile up stream, and the mile-run ended sixty yards down stream with the boat heading exactly opposite to her original direction. This erratic action of the compass was discovered to be due to heeling, or inclining from the horizontal position, and that it could not be corrected in that boat on account of the near proximity to the compass needle of considerable masses of iron that were liable to have their position changed while the vessel was submerged."

To overcome the above-mentioned difficulties, Mr. Holland invented a device and took out a patent (No. 492,960) for a triangular drag, which was expected to keep the vessel on a true course when under water. This triangular drag was the novel feature of Mr. Holland's 1893 design and was intended to automatically steer the vessel on a straight course when submerged. It was intended to operate on the following ingenious principle:

Holland's Steering Device

While the vessel was running on the surface the steering gear was under the control of the steersman. In this condition the compass could be adjusted, as the vessel was on a substantially level keel and the masses of metal remained fixed in their relation to the compass, but when the vessel was caused to "dive" the masses of metal changed their relation to the adjusting magnets and the compass was thrown out of truth. Therefore, on beginning a dive the vessel was first started on the surface on the course it was intended to follow submerged until the triangular drag, being drawn through the water, assumed "a direction parallel to the axial line of the boat by reason of the rush of water against said drag, and especially against the rib thereon." As soon as the boat was on her course, the steersman was expected to disconnect his hand steering gear and allow the drag to control the rudder to hold her to her original course. Mr. Holland maintained that any departure from a straight line will immediately cause the drag to produce a swinging motion of a lever, which was expected to throw the rudder in a reverse direction, thus returning the ship to her original course.

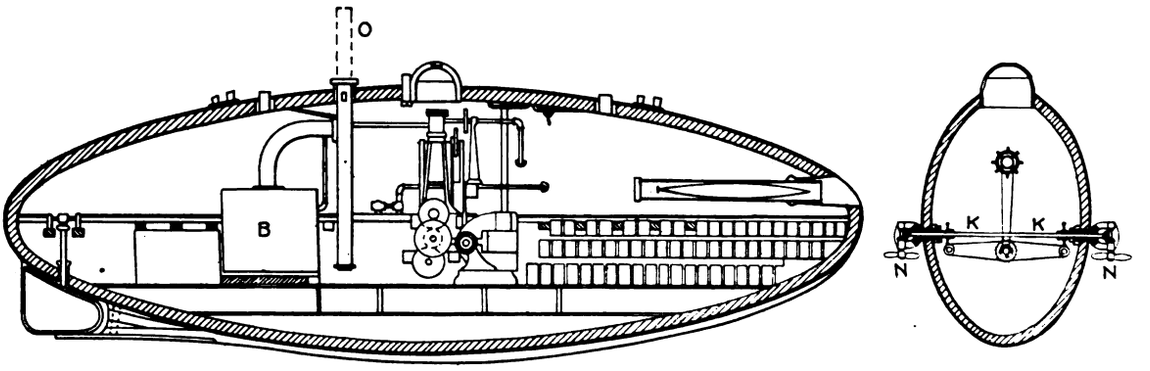

Fig. 17.—The Baker Submarine

The novel feature of this design was the side propellers, N-N, carried in revolving housings which were rotated by the depth-control man so as to exert a thrust in the proper direction to "push" or "pull" the vessel downward and forward at the same time. The propellers were driven by the athwart shaft, K-K. A steam boiler, B, furnished steam for surface propulsion and accumulators forward supplied power for submerged work. O was a telescoping smokestack.

Another automatic steering device operated by the pressure of the water was expected to automatically control the depth of submergence, it being only necessary, theoretically, to move a control lever to a point on a dial corresponding to the desired or "predetermined" depth of submergence and the horizontal diving rudder would then be automatically manipulated to incline the bow of the vessel down so as to dive, until the desired depth was reached, and then to be manipulated to throw the bow up or down to maintain that depth.

In further describing his 1893 design for the *Plunger,* for which he had received the award based on a guarantee of performance, Mr. Holland describes her as follows:

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"The boat now being built for the United States Government satisfies all the requirements detailed earlier in this article. It will have a length overall of 85 feet; diameter, 11½ feet; total displacement, 168 tons, and a light displacement of 154 tons. The guaranteed speed on the surface will be 15 knots, the speed awash 14 knots, and submerged 8 knots. At full speed the boat will have an endurance of twelve hours and a radius of action of 1,000 miles at slower speed. The endurance, when submerged, will be ten hours at a speed of 6 knots.

"The boat will be propelled by triple screws, operated by three independent sets of triple expansion steam engines, capable of developing 1,625 indicated horsepower. There will also be electric storage batteries and a motor of 70 horsepower for submerged running. The armament will consist of two expulsion tubes and five Whitehead torpedoes.

"Steering on the horizontal plane while submerged is accomplished by an automatic apparatus that performed very well in one of this boat's predecessors. Steering in the vertical plane is also done automatically, and with considerable exactness, while submerged. Steering in both planes can also, at the same time, be controlled manually.

"There will be a steel armored turret, 4 feet high, to protect the pilot and smokestack, and the hull will be covered by 3 feet of water while the vessel runs awash to attack.

"When engaged in harbor defense duty its position will be outside the outer line of harbor defenses—that is, beyond the range of the guns defending the entrance. While performing this duty it will lie awash—that is, with only the top of its turret over the surface of the water. On the approach of an enemy's vessel the smokestack will be shipped and the aperture on top of the turret through which it passed will be quickly closed watertight. She will then run in a direction to intercept the enemy's ship, still remaining in the awash condition, until she comes near enough to be discovered by the lookouts on the ship, when she will go from the awash to the entirely submerged condition. The distance from the ship at which she will dive will depend on the weather. In rough weather she can come quite close without being observed.

"Having come within a distance that the operator estimates at two or three hundred yards from the ship, the diving rudders are manipulated so as to cause the top of the turret to come for a few seconds above the surface of the water. During this short exposure of the turret—much too short to give the enemy a chance to find its distance and train a gun on it capable of inflicting any injury—the pilot ascertains the bearing of the enemy's ship, alters his course or makes another dive if necessary. If he finds that the submarine boat is within safe striking distance, say 100 yards, a Whitehead torpedo is discharged at the ship. A heavy explosion within six seconds after the torpedo is expelled will notify the operator that his attack has been successful, and he may then devote his attention to the next enemy's ship that may be within reach.

"When the boat is running on the surface of the water, with full steam power, and it becomes necessary to dive quickly, the pilot gives the order, 'Prepare to dive.' The oil fuel is instantly shut off from the furnace, the valves are opened to admit water to the water ballast tanks, an electric engine draws down the smokestack and air-shaft into the superstructure, and moves a large, massive sliding valve over the aperture on the turret through which the smokestack passes. These operations will be completed in about thirty seconds, when the boat is in the awash condition and prepared to dive. In twenty seconds more it will be running horizontally at a depth of twenty feet below the surface of the water and quite beyond the reach of the enemy's projectile."

The author submitted designs of a twin screw vessel, 80 feet long, 10 feet beam and 115 tons displacement, with 400 horsepower steam engines for surface propulsion and 70 horsepower motors for submerged work. This design introduced several new and novel features into the art of submarine navigation which have been the cause of considerable scientific discussion. The design called for a *double hull* vessel, the spaces between the inner and outer hulls forming water ballast tanks; the design also called for twin screws and four torpedo tubes, two firing forward and two aft.

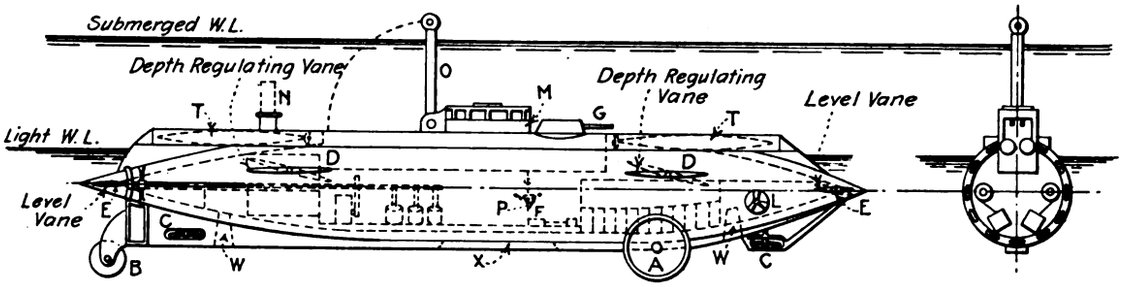

Fig. 18.—Lake 1893 Design as Submitted to the U.S. Navy Department

Novel features consisted in (A) wheels for running on the bottom; (B) rudder forming also a steering wheel when navigating on the bottom; (C-C) propellers for holding vessel to depth when not under way; (D-D) depth regulating vanes or "hydroplanes" for causing vessel to change depth while under way and to accomplish the changes of depth on an even keel; (E-E) horizontal rudders or "leveling vanes" designed to automatically hold the vessel on a level keel when under way; (F) a weight automatically controlled by a pendulum; (P) mechanism to correct trim; (G) gun arranged in watertight revolving turret for defense purposes or attack on unarmored surface craft; (L) propeller in tube for swinging vessel at rest to facilitate "pointing" her torpedoes; (M) conning tower; (N) telescoping smokestack; (O) observing instrument arranged to turn down on deck when under way; (T-T) torpedo tubes, two firing forward and two aft; (W-W) anchoring weights to hold the vessel at rest at any desired depth between the surface and bottom; (X) an "emergency keel" which would be automatically released if the vessel reached an unsafe depth. She was a double-hull vessel, water being admitted to the space betwen the inner and outer hulls and in trim tanks forward and aft to effect submergence. A diving compartment was also provided to enable the crew to leave or enter the vessel while submerged.

LAKE'S 1893 DESIGN

The new and novel feature which attracted the most attention and skepticism regarding this design was (the author was later informed by a member of the Board) in the claim made that the vessel could readily navigate over the waterbed itself and that while navigating on the waterbed a door could be opened in the bottom of a compartment and the water kept from entering the vessel by means of compressed air, and that the crew could, by donning diving suits, readily leave and enter the vessel while submerged.

Another novel feature was in the method of controlling the depth of submergence when navigating between the surface and waterbed. The vessel was designed to always submerge and navigate on a level keel rather than to be inclined down or up by the bow to "dive" or "rise." This maintenance of a level keel while submerged was provided for by the installation of four depth regulating vanes which I later termed "hydroplanes" to distinguish them from the forward and aft leveling vanes or horizontal rudders. These hydroplanes were located at equal distances forward and aft of the center of gravity and buoyancy of the vessel when in the submerged condition, so as not to disturb the trim of the vessel when the planes were

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inclined down or up to cause the vessel to submerge or rise when under way.

I also used, in conjunction with the hydroplanes, horizontal rudders which I then called "leveling vanes," as their purpose was just the opposite from that of the horizontal rudder used in the diving type of vessel. They were operated by a pendulum controlling device to be inclined so as to always maintain the vessel on a level keel rather than to cause her to depart therefrom. When I came to try this combination out in practice I found hand control of the horizontal rudders was sufficient. If vessels with this system of control have a sufficient amount of stability, they will run for hours and *automatically maintain both a constant depth and a level keel,* without the depth control man touching either the hydroplane or horizontal rudder control gear.

This automatic maintenance of depth without manipulating the hydroplanes or rudders was a performance not anticipated nor claimed in my original patent on the above mentioned combination, and what caused these vessels to function in this manner remained a mystery, which was unsolved until I built a model tank in 1905 in Berlin, Germany, and conducted a series of experiments on models of submarines. I then learned that the down pull of a hydroplane with a given degree of inclination varied according to its depth of submergence, and that the deeper the submergence, the less down pull. This works out to give automatic maintenance of depth as long as the vessel is kept at a constant trim on a substantially level keel, and I have known of vessels running for a period of over two hours without variation of depth of one foot and without once changing the inclination of either the hydroplanes or the horizontal rudder.

The capability of this arrangement of hydroplanes and horizontal rudders to control the depth of submergence was questioned and doubted for many years. As late as 1902, nearly ten years after I first submitted this method of control to the United States Navy Department, Naval Constructor L. Y. Spear, U. S. N., testifying before the Committee of Naval Affairs, House of Representatives, in reference to the "Lake even keel boat" and my use of hydroplanes, said, "As an expert I do not think he will make his hydroplanes work," and strongly contended that submergence by inclining the vessel itself was the proper method.

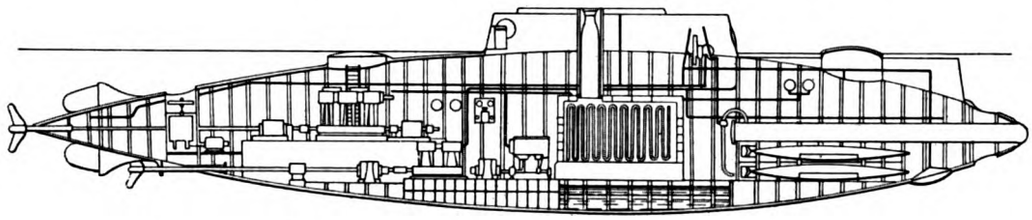

Fig. 19.—The *Plunger* (Holland Type Submarine), Launched in August, 1897

(Machinery not drawn to scale. The engines of 1,600 horsepower. with the necessary auxiliaries, nearly filled the after portion of the vessel.)

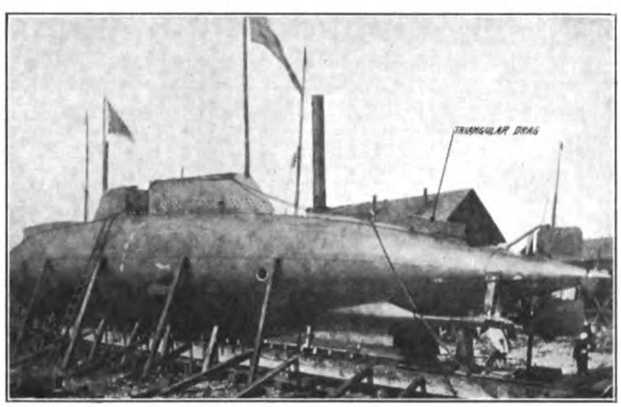

Fig. 20.—The *Plunger* (Holland Type) Ready to Launch

Novel features of her design were automatic "diving" and steering devices, triple screws, armored conning tower and a large steam power plant.

Several years later, in 1908, in Paris, I met Captain Laubeuf, the celebrated French naval constructor, who has perhaps done more towards perfecting the French submarines than any other designer, and he informed me that after the French Government had their sad experience in the loss of the *Lutine* and *Farfadet* with their crews, they had changed all their diving boats into even keel boats and were now using substantially my method of even keel submergence with hydroplane control. He also informed me that they had, at that time, thirty-five new boats under construction to operate on the even keel principle, eighteen of which were of 550 tons displacement. Captain Laubeuf was kind enough to compliment me as having been the first to introduce this method of submerged control.

Commander Murray F. Sueter, Royal British Navy, in his most complete work on "The Evolution of the Submarine Boat, Mine and Torpedo, from the Sixteenth Century to the Present time," published in 1907, said:

"After scrutinizing all the information available I am certain that several features of the 'Lake' design will be embodied by most nations in the construction of future boats, the chief of which, perhaps, are 'the even keel method of submergence' in preference to the 'dynamical dive' of the Holland boats; also the provision of a safety keel and diving compartment. This latter forms a ready means of communicating with the surface should the boat, through some small mishap, find herself on the bottom and unable to rise."

Sir Trevor Dawson, formerly (R. N.) manager of "Vickers," in discussing submarine boats before the Institution of Naval Architects in 1907, said:

"Mr. Lake mentioned the question of the importance of horizontal stability and the use of hydroplanes. I think these have been used by the Holland Company in America in connection with the experiments they made for the American Government. In one of the boats I saw they gave me particulars of such experiments. I know, too, that they have been used considerably in France with satisfactory results, and I think his contention as to the importance of horizontal stability, as things exist to-day, is fully justified."

Captain Edgar Lees (R. N.), who was the officer in charge of the British submarines, said:

"I may say, with regard to the features that Mr. Lake has brought to our notice, the hydroplane, for instance, and get-

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ting good freeboard and seaworthy boats, the mere fact that they have been largely copied and that most nations build these submarine boats is, Mr. Lake contends, a conclusive proof that he has been for years on the right tack. Well, I do not think at the present moment submarine boats are being built in any country without hydroplanes, in order to dive, if desired, almost horizontally."

One of the latest contract requirements of the United States Government, specifying the characteristics of the new boats to be built under the appropriation for submarines for the year 1915, states:

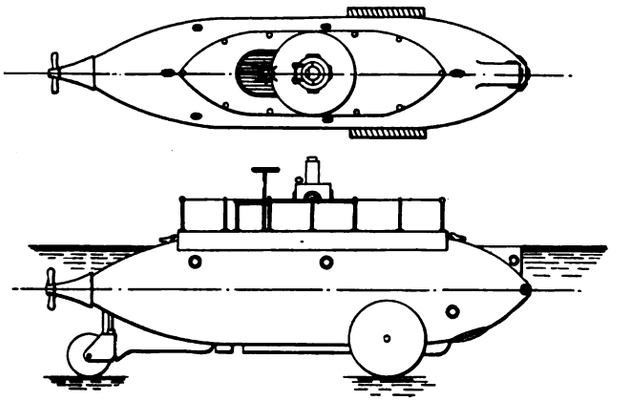

Fig. 21.—*Argonaut* as Originally Built

Surface buoyancy about 12 percent.

"The vessel shall make also the necessary trials to demonstrate her ability to effect initial submergence, to maintain submergence underway, and to change depths without exceeding an angle of inclination of one (1) degree." This, in substance, calls for "even keel submergence" when one considers that it was common for early boats of the diving type to take on an inclination of 15 to 20 degrees, and inclinations of as much as 45 degrees were not unknown.

All governments and submarine builders have now in their latest boats adopted the method of even keel submergence by the use of hydroplanes, and the author is much gratified that this method of control has been finally adopted as the standard, as I believe none of the latest modern submarine boats will make the uncontrollable dives to the bottom, common in the boats of the diving type, and which have been accompanied in many cases by the loss of their crews.

The author did not make a proposal to build a boat from his designs as submitted in 1893, but offered to co-operate with the Government in developing submarines under his patents, which were then pending, on such terms as the Government might desire. Not being fortunate enough, however, to secure the financial assistance of the Government in developing my inventions for the protection of our country, I turned my attention for a time to applying my inventions to commercial purposes and to prove the practicability of navigating on the bottom.

THE ARGONAUT

For this purpose I built, in 1894, a small wooden vessel called the *Argonaut, Jr.* This vessel was provided with three wheels, two on either side forward, and one aft, the latter acting as a steering wheel. When on the bottom the wheels were rotated by hand by one or two men inside the boat. Her displacement was about 7 tons, yet she could be propelled at a moderate walking gait when on the bottom. She was also fitted with an air lock and diver's compartment, so arranged that by putting an air pressure on the diver's compartment equal to the water pressure outside, a bottom door could be opened and no water would come into the vessel. Then by putting on a pair of rubber boots the operator could walk around on the sea bottom and push the boat along with him and pick up objects, such as clams, oysters, etc., from the sea bottom.

Experiments with this vessel on the bottom of Sandy Hook Bay convinced sufficient people who were permitted to witness the experiments that submarine navigation in this manner was practicable, and I succeeded in raising sufficient capital to build a larger vessel to continue my experiments on a larger scale. Therefore, in 1895, I designed the *Argonaut*.

At this time I was living in Baltimore, Md., so I made a contract with the Columbian Iron Works & Dry Dock Company of that city for her construction. This company was also building for the Holland Torpedo Boat Company the *Plunger*, which was being constructed for the Government under the 1893 appropriation. Both vessels were completed about the same time. They were launched in August, 1897, and went into dry dock together.

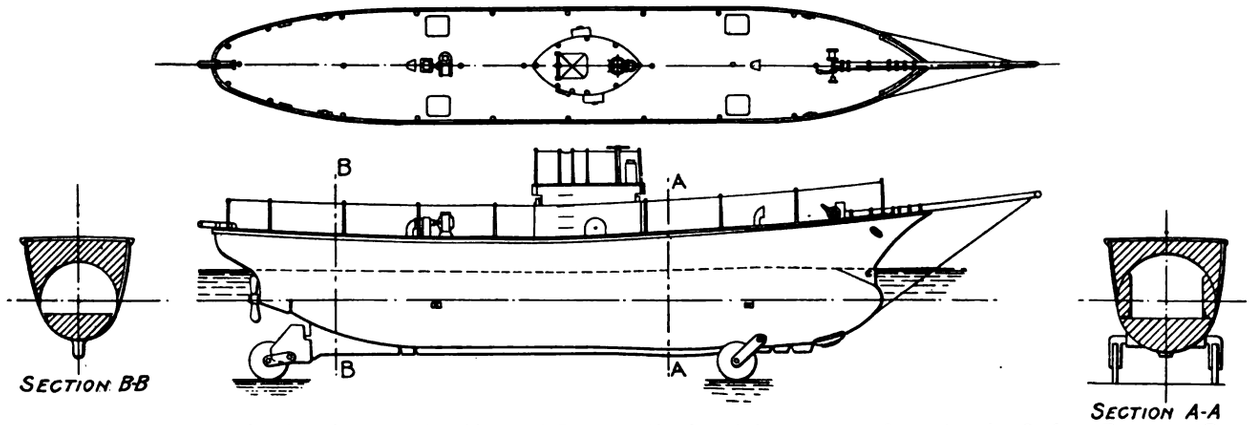

Fig. 22.—The *Argonaut* After Lengthening and Addition of Buoyant, Shipshaped Superstructure, Increasing the Surface Buoyancy Over 40 Percent

The bowsprit formed a hydraulic cushioning device to prevent injury in case of a head-on collision with an obstruction when running on the bottom. On encountering an obstruction of less height than the bowsprit, the bobstay acted as an inclined plane, and would lift her bow up so she would go over. A 6-inch pump is shown mounted on her after deck, which was used in transferring coal from a sunken vessel to a submarine freight boat.

The *Argonaut* as originally built was 36 feet long and 9 feet in diameter. She was the first submarine to be fitted with an internal combustion engine. She was propelled with a 30 horsepower gasoline (petrol) engine driving a single screw propeller. She was fitted with two toothed

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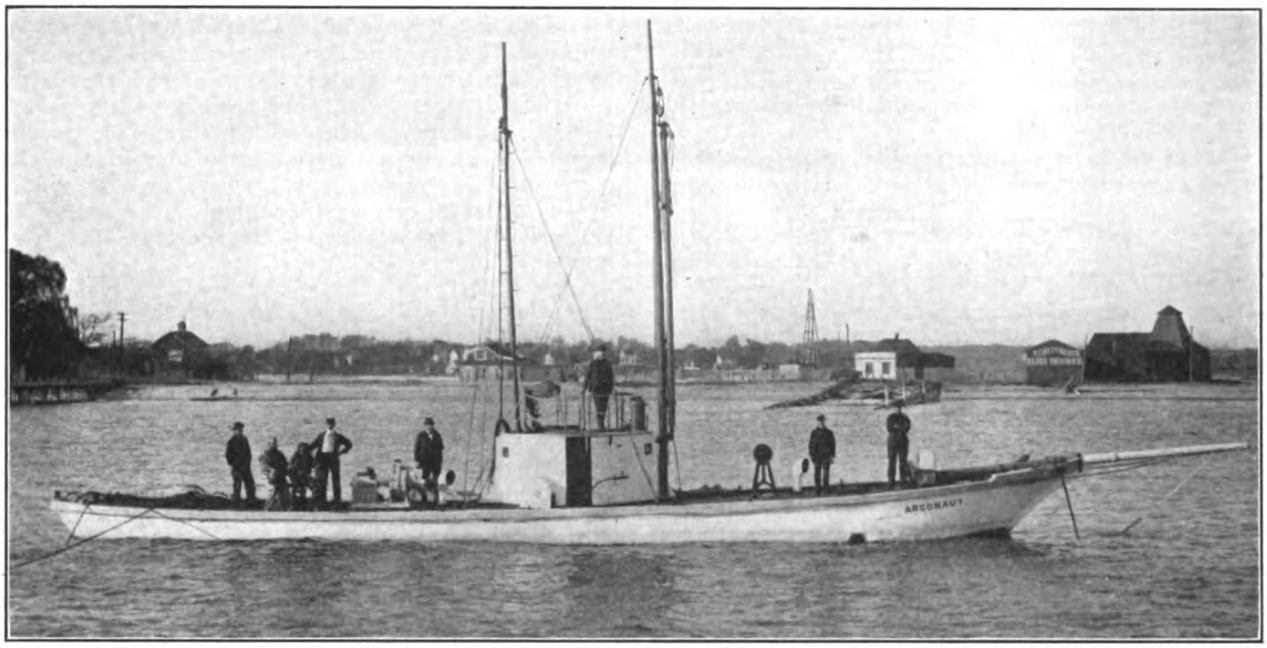

Fig. 23.—View of the Lake Submarine *Argonaut*, Showing Shipshaped Superstructure

driving wheels forward which were revolved by suitable gearing when navigating on the waterbed, or they could be disconnected from this gearing and permitted to revolve freely, propulsion being secured by the screw propeller. A wheel in the rudder enabled her to be steered in any direction when on the bottom. She also had a diver's compartment to enable divers to leave or enter the vessel when submerged, to operate on wrecks or to permit inspection of the bottom or to recover shellfish. She also had a lookout compartment in the extreme bow, with a powerful searchlight to light up a pathway in front of her as she moved along over the waterbed. This searchlight I later found of little value except for night work in clear water. In clear water the sunlight would permit of as good vision without the use of the light as with it, while if the water was not clear, no amount of light would permit of vision through it for any considerable distance.

Propelling Machinery of the Argonaut

As the *Argonaut* was built principally to further test out the possibility of navigating on the waterbed in exploration and commercial work, she was propelled both when on the surface and submerged by her gasoline (petrol) engines. Storage batteries were carried only for lighting purposes. The air to run her engines was first drawn down into the vessel through a hose extending to a buoy floating on the surface. Later she was fitted with pipe masts, which enabled her to navigate on the bottom in depths up to 50 feet. She functioned satisfactorily from the start. We found we could readily navigate over any kind of bottom, soft or hard, by regulating her buoyancy to suit, and she would, due to her buoyancy, readily climb over any obstruction that did not reach higher than her forefoot.

There were three things that caused us to delay for a few weeks her departure on a submarine exploration trip. The first was the escape of gasoline (petrol) fumes in the boat. When first built, fuel tanks were built in the hull itself and formed an integral part of the vessel. Special care was given to make these fuel tanks tight. They were tested under hydraulic pressure and found to be tight, but the fumes from gasoline (petrol) are very searching and after filling the fuel tanks and keeping them filled over night, gasoline (petrol) fumes were found to exist in the boat the next morning to such an extent that I would not venture to make a start until a fuel tank had been built outside of the vessel, where any escape of fumes would not form an explosive mixture. I followed this practice in all our later gasoline (petrol) engined boats, which largely eliminated the danger from carrying gasoline (petrol) as a fuel. A number of explosions have occurred, in some cases with fatal results, from gasoline (petrol) fuel being carried in built-up tanks within the hull itself.

The next cause of delay was due to the escape of and collection of carbon monoxide within the vessel. This developed on our first submarine run. After we had been down about two hours, some of us commenced to experience a dull pain at the base of the brain and great lassitude. On coming to the surface a couple of our men collapsed completely, and one was very sick all night. I could not understand the cause of this, as nothing of the kind had occurred in my previous hand-propelled vessel, so we made another submerged run the following day, and after about the same period of time the pain in the head and lassitude came on again. I then discovered that the engine would occasionally backfire out into the boat and that gas was escaping by the piston rings into the base of the engine and from there into the boat.

To overcome this difficulty I installed what I called an induction tank, which was piped up to the air intake of the engine and also the engine base. A check valve admitted air into this induction tank. When the engine was started the check valve was automatically lifted and induced a flow of air through the tank, in which a slight vacuum was maintained, which also served to draw the gases out from the engine base. In case of a backfire, the check valve automatically closed and the gases from the backfire were caught in the induction tank, from which they were drawn out on the next stroke of the engine. This solved this difficulty and thereafter the air was always

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fresh and pure when running submerged, even after a submergence of several hours' duration.

Like Mr. Holland, I also had difficulty on our first submergence in always knowing "where we were going." Our compass was first installed in the boat itself, where it was surrounded by steel. The compass adjuster had searched for and found what he considered the most "neutral" place in the ship to install the compass, and had adjusted it by magnets in the usual manner, but it was too "logy" for correct navigation and we were forced finally to install it in a bronze binnacle directly over the conning tower, where it could be viewed by mirrors from the steersman's station. This cut out most of the adjusting magnets and the compass was nearly accurate on all courses. Submarine navigation thus became reliable.

CAPABILITIES OF THE ARGONAUT

On the completion of these changes the *Argonaut* was taken down the Chesapeake Bay to Hampton Roads, where several months were spent in examining the bottom conditions in the bay and out on the ocean, and in locating and picking up cables and in examining wrecks. The Spanish-American War was on at this time and an effort was made to interest the Government officials in charge of the mines at Fortress Monroe. I tried to get some of the officers to go down in the *Argonaut* and see how easily by observation mine cables could be located and cut if desired, as I was making almost daily submerged runs in their vicinity. Finally I received peremptory orders not to submerge within a mile of the mine fields, as I might accidentally sever one of the cables, and then, as the officer in charge said, "There would be the devil to pay in Washington."

It was about this time that Admiral Sampson's fleet was holding at great expense its long vigil outside of Santiago, waiting for Cervera's fleet to come out. Our fleet was kept outside the harbor for fear of the mines, while here in Hampton Roads all this time was a vessel capable of clearing away the mine fields, but which was not given serious consideration, as it was thought that the submarine was impracticable. Experiments were also made showing the possibility of submarines establishing submarine telephone stations at known locations on the bottom of the ocean. In January, 1898, while the *Argonaut* was submerged, telephonic conversation was held from submerged stations with Baltimore, Washington and New York.

THE VOYAGE FROM NORFOLK TO NEW YORK

In 1898, also, the *Argonaut* made the trip from Norfolk to New York under her own power and unescorted. In her original form she was a cigar-shaped craft with only a small percentage of reserve buoyancy in her surface cruising condition. We were caught out in the severe November northeast storm of 1898 in which over 200 vessels were lost, and we did not succeed in reaching a harbor in the "horseshoe" back of Sandy Hook until three o'clock in the morning. The seas were so rough they would break over her conning tower in such masses I was obliged to lash myself fast to prevent being swept overboard. It was freezing weather and I was soaked and covered with ice on reaching harbor.

This experience caused me to apply to the *Argonaut* a further improvement for which I had already applied for a patent. This was to build around the usual pressure resisting body of a submarine a shipshape form of light plating which would give greater seaworthiness, better lines for surface speed, and make the vessel more habitable for surface navigation. It would, in other words, make a "seagoing submarine," which the usual form of cigar-shaped vessel was not, as it did not have sufficient surface buoyancy to enable it to rise with the seas, and the seas would sweep over it as they would sweep over a partly submerged rock.

ADDITION OF BUOYANT SUPERSTRUCTURE

The *Argonaut* was therefore taken to Brooklyn, 20 feet added to her length, and a light watertight buoyant superstructure of shipshape form added. This superstructure was opened to the sea when it was desired to submerge the vessel, and water was permitted to enter the space between the light plating of the shipshape form and the heavy plating of the pressure resisting hull. This equalized the pressure on the light plates and prevented their becoming deformed due to pressure. The superstructure increased her reserve of buoyancy in the surface cruising condition from about 10 percent to over 40 percent and she would rise to the seas like any ordinary type of surface vessel, instead of being buried by them in rough weather.

This feature of construction has been adopted by the Germans, Italians, Russians, and in all the latest type of French boats. It is the principal feature which distinguishes them in their surface appearance from the earlier cigar-shaped boats of the diving type. This shipshape form of hull is only suited to level keel submergence and must be controlled by hydroplanes.

I also departed from the cigar-shaped inner hull and was granted a patent on a form of pressure resisting hull with rising axes. This improvement overcame the tendency to "dive by the head" common to the cigar-shaped form, increased the surface speed on an equivalent displacement, and gave a considerable increase in metacentric height over a vessel of equivalent length and beam.

(*To be continued.*)

Davits and the New Requirements*

BY HARRY W. BROADY †

The new law requires many more lifeboats for passenger steamers than were required in the old rules. A very important question for the shipowner to settle is the stowage of all these new lifeboats. A certain minimum number of davits are required, depending upon the length of the ship. There will almost always be more lifeboats required than sets of davits. These extra lifeboats can be stowed in different ways. They may be nested—i. e., two lifeboats, one on top of the other, under one set of davits. They can be double banked under double-acting davits—i. e., two units, one inboard of the other, with single or nested boats in each unit, all to be served by one set of davits. There can be several units of lifeboats arranged across the deck, handled by one set of davits, by means of some feeding arrangement which places the boats under the davits. It has been previously stated that it is not a safe policy to place too many boats under one set of davits. This is especially true when the boats are of large capacity. The limit should not be over 300 persons, or, say, four boats for one set of davits, and that only where all the mechanical arrangements are of the best and safest types, so that the handling of the boats can be carried out quickly and with certainty in any emergency.

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* Concluded from the July issue.

† Chief Engineer, Welin Marine Equipment Company, Long Island City, N. Y.

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One single nest of two boats can be taken care of by all the different classes of davits, if suitable chocks, easily disengaged grips and non-toppling blocks are provided. The latter is especially important for recovering the falls for launching the second boat.

Double-banked boats under one set of davits can only be taken care of to advantage by trolley and track davits and double-acting quadrant davits. The round-bar and

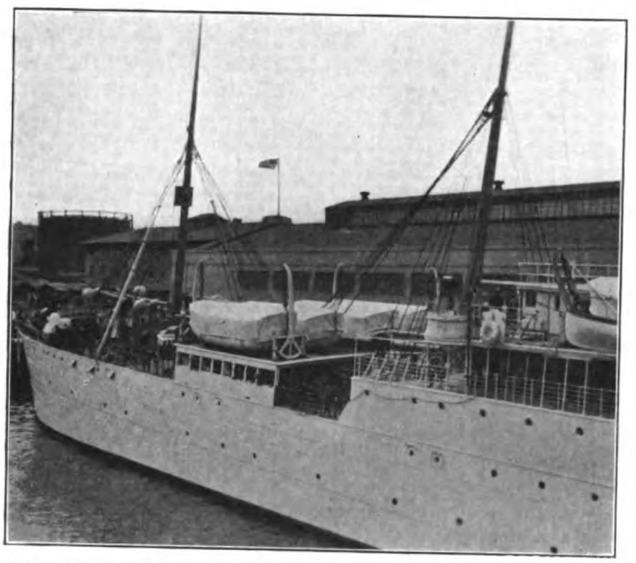

Fig. 10.—Installation of Double-Acting Welin Quadrant Davits

the pivoted davits would have to be provided with such long arms and the power required to swing the inside boats out would be so great as to make it impossible to work them by hand. Gravity davits are, of course, entirely out of the question. The trolley and track davits will, as previously mentioned, be rather heavy and complicated, but the mechanically operated quadrant davit is peculiarly well adapted for double acting. It is only necessary to increase the quadrant and extend the frame somewhat inboard, thus making it possible to swing the arm in over the inner boat. They are now extensively used. In some cases the inner boats are placed on a deck above. The davits have then been designed to reach over and handle this upper boat as well as the boat directly in the way of the davits. This has worked very well in practice. Double acting Welin quadrant davits are shown in Fig. 10.

Many different schemes have been worked out for feeding boats placed inboard to the davits. A very unique and efficient way was adopted on board the Cunard liner *Aquitania*. Ordinary double acting Welin quadrant davits were placed on the deck at the side of the ship in the usual manner. Double acting Welin quadrant davits were placed inboard in way of the other davits; they were fitted with powerful chain blocks to readily lift the boats. These inboard davits act as feeders for the outboard davits.

Marine railways running athwartship are also used for feeding the boats, but they will be very complicated if they are to be effective. They will in most cases be a very troublesome obstruction on the decks, as shown in Fig. 11, where the complicated driving gear, which is difficult to get at, can be seen.

Single Davits and Booms

Single davits and booms are sometimes used on board ships for launching boats. They ought never to be used for any boat except dinghies or working boats, as there is always the danger of spilling people out of a boat handled in one single whip. The state of equilibrium is very sensitive in a boat hanging like this in the air. The booms are generally used for launching pontoon or second class boats stowed far inboard. These boats are more like rafts and will float off a ship when sinking, if they do not foul in rigging, etc. It is therefore just as well that provision is made for launching them with a boom when the power and time are available.

Hoisting and Lowering Controls

Hoisting and lowering controls are now used to some extent on board of big liners. The height from the boat deck to the water will in some cases on big transatlantic liners be as much as 70 feet. With triple blocks, this means about 500 feet of about 1½-inch diameter hemp rope. By using wire falls and hoisting and lowering controls, double or perhaps single blocks can be used. The advantages in such a case are very clear, especially as the davits almost always take care of several boats, and by this means the recovery of the blocks and tackle can be made in very quick time.

A hoisting and lowering control is a very complicated affair, if it is to be effective. The two drums, one for each davit falls, must be worked simultaneously so as to make the lowering safe. It is practically impossible to work the mechanical brakes on two independent drums so evenly that the boat will always be on an even keel. In the case of simultaneously working drums they must also be arranged so that the drums can be worked independently. This is necessary to be able to bring the inclined boats to an even keel when the ship is heeling or to set the ropes up taut after the boat has been recovered and is in the chocks. The hoisting control must be provided with gearing for quick recovery of the falls in order to launch the remainder of the boats on the deck in turn, and also with gearing for slower recovery of the boats, both gears being arranged to work either with power or hand drive, as may be required. The power supply should be inde-

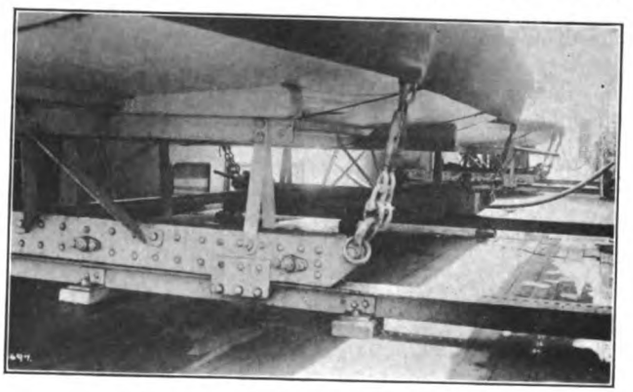

Fig. 11.—Athwartship Marine Railway

pendent of the driving power of the ship. Electric motors and storage batteries are most reliable.

There are many schemes patented in this line. Some have a lowering gear in each lifeboat, which is quite impossible, as it will take up too much room and will be very expensive. A very neat arrangement has been installed on board the big Hamburg-American liners *Imperator* and *Vaterland*, as shown in Fig. 12. The inventor is Mr. Axel Welin of London. The drums are in one casting and are placed on an eccentric shaft so that they can be moved by a lever either against the shoe of a brake or against a friction drive. In the neutral position the drums run freely on the shaft. The adjustment of the boat to an even keel is made possible by an independent gear consisting of two

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drums and a worm gear drive. The standing parts of the falls are wound one around each drum and in opposite directions. By turning the drums one line is taken in while the other is paid out; thus the whole thing is balanced and it requires very little power to adjust the boat to an even keel. This can be done, if necessary, even when the boat is being lowered.

Another interesting hoisting and lowering arrangement is the use of a spool drum. This type was used extensively in a very crude form on whaling ships. The hoisting gear

Fig. 12.—Hoisting and Lowering Control on the *Vaterland*

was provided with a third drum around which a driving rope is wound. When the lifeboat is to be hoisted up this rope is connected to a rope leading to and worked by a winch. The trouble with this arrangement is that the driving rope must be wound up each time before using, in most cases by hand.

The winches can always be used on board ship when they are in running order for hoisting up a lifeboat. This only necessitates a few snatch blocks on deck and a line from the winch to the davits.

Under all conditions the ordinary rope falls bent around a suitable bollard or belaying pin is the safest way for lowering away a lifeboat. The falls are then under absolute control. It is also the cheapest and simplest way, not requiring experience or special training, which is of utmost importance in times of disaster.

Testing of Davits

The new rules necessitate actual testing of the davits on board a ship. This is quite an expensive and bothersome operation. The ship will have to be first listed to the prescribed maximum list and the empty boat swung out on the high side. The list must then be increased to 15 degrees and the loaded boat swung out on the low side. Both of the above operations have to be carried out to test each set of davits, for all davits on board.

The only thing that happens when the loaded boat hangs in the fully swung out arms on the low side, when the ship is listed to 15 degrees from an upright position, is that the stresses in the davits increase. How great the increase of the stresses is with fully loaded boat and 15 degrees list can very easily be graphically laid out. This is shown for round-bar, pivoted and quadrant davits in Figs. 13, 14 and 15. The graphical method is so simple that it is not necessary to further explain it. For round-bar davits

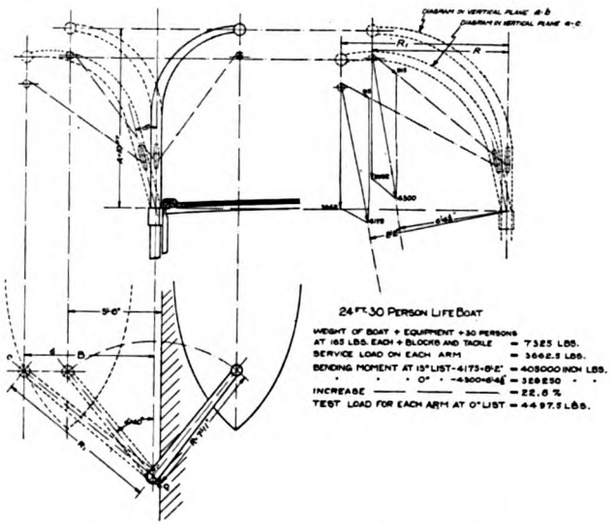
24 FT. 30 PERSON LIFE BOAT
WEIGHT OF BOAT + EQUIPMENT + 30 PERSONS AT 165 LBS. EACH + BLOCKS AND TACKLE = 7325 LBS.
SERVICE LOAD ON EACH ARM = 3662.5 LBS.
BENDING MOMENT AT 15° LIST = 405000 INCH LBS.
INCREASE = 22.6 %
TEST LOAD FOR EACH ARM AT 0° LIST = 4497.5 LBS.

Fig. 13.—Diagram of Stresses, Round-Bar Davit

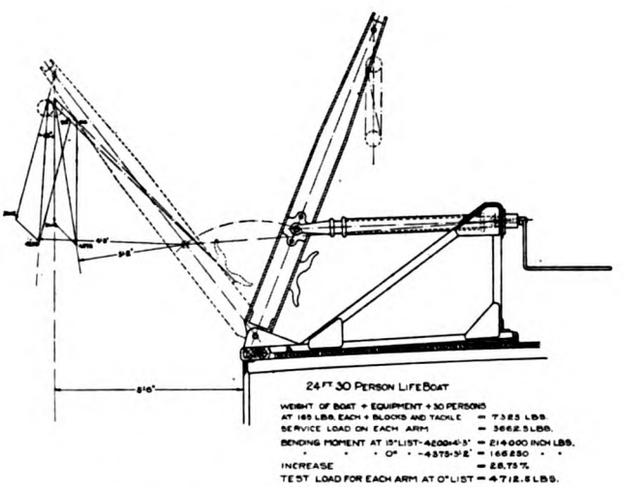
24 FT 30 PERSON LIFE BOAT
WEIGHT OF BOAT + EQUIPMENT + 30 PERSONS AT 165 LBS. EACH + BLOCKS AND TACKLE = 7325 LBS.
SERVICE LOAD ON EACH ARM = 3662.5 LBS.
INCREASE = 28.73 %
TEST LOAD FOR EACH ARM AT 0° LIST = 4712.5 LBS.

Fig. 14.—Diagram of Stresses, Broady Davit

the following empirical formula is also worked out and will give results sufficiently accurate:

$$\text{Increase percent} = \frac{100}{R}\sqrt{(.259A + .966B)^2 + R^2 - B^2} - 100. \qquad (3)$$

A = height of davit above bearing bracket in feet.
B = outreach — distance between center line of boat in extreme outboard position and fore and aft line through the centers of the vertical part of the davits when ship is in upright position. Dimension in feet.
R = radius of overhang of davit arm in feet.

Or

$$\text{Increase percent} = \frac{100}{R}\sqrt{(.259A + .966R \sin.\ \alpha)^2 + R^2 \cos.^2 \alpha} - 100. \qquad (4)$$

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Where A and R are the same as above.

α = angle between davit in outboard position and fore and aft line.

Example:

$A = 16'$, $R = 7'\ 11''$, $\alpha = 40°$. See Fig. 13.

$$\frac{100}{79} \times (.259 \times 16 + .996 \times 7.9 \times \sin. 40° - 7.9^2 \times \cos.^2 40°) - 100 = 22 \text{ percent.}$$

Turning out the empty boat against the maximum possible list with quadrant and pivoted davits is equivalent

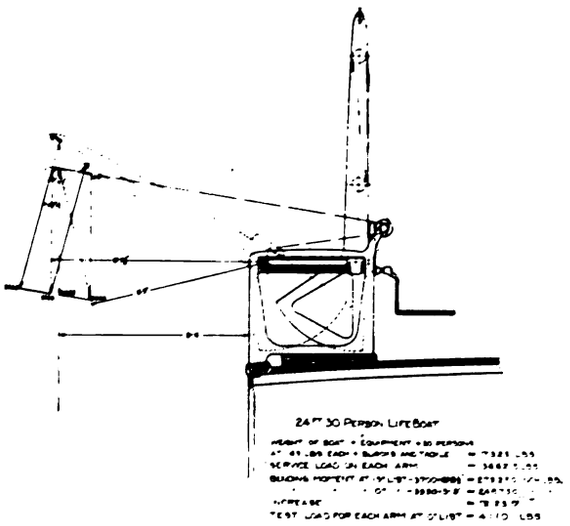

Fig. 15.—Diagram of Stresses, Welin Quadrant Davit

to turning out the boat with the ship in an upright position, but with an increased load. The increase is fully met in using a test load to give the increase in stresses due to a 15 degree list as determined above. The proposed manner of testing davits to comply with the law is satisfactory for pivoted and quadrant davits. The rule will not do for round-bar and trolley and track davits, however, as a simple increase of load with the ship upright will not give the same conditions for turning these davits out as when the ship is listed. In the latter classes there is only the friction to overcome with the ship upright in

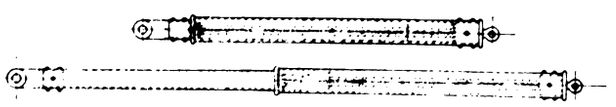

Fig. 16.—Broady Telescopic Screw in Closed and Extended Positions

turning out the boat, but with the ship listed there is a gravity force to overcome, and this increases very rapidly with increasing list.

The writer has worked out the following method, which will simplify the testing, and therefore might be adopted by the authorities:

By this method, if the davits are tested on board ship, it is not necessary to list the ship to obtain exactly the same conditions in regard to the davits that exist when the ship has listed. The davits could just as well be tested and approved at the builders' plant by the official inspectors, just as lifeboats are now inspected and approved.

Rule for Testing Davits

A test weight is hung in each davit arm when in the inboard position, the arm is then fully swung out and the weight removed. When the davit is fully swung out with the above test weight the stresses in the davit arm will be the same as those set up with one-half the service load fully swung out in davit arms with list of 15 degrees on board ship. This is to apply to quadrant and pivoted davits for requirements both as to strength and operation, but for round-bar and trolley and track davits, only as to strength.

The above test weight is to be such as to give the increase in stresses as determined in accordance with above described graphical method, also for round-bar davits by formula (3).

Example.—Davits: Height = 10 feet, radius of overhang = 7 feet 11 inches. a = 40 degrees. Increase in accordance with formula (3) = 22 percent.

Boat: 24 feet by 7 feet by 3 feet — 30 persons capacity.

Weight:

Boat	2,050	pounds	
Equipment	200	"	
Thirty persons at 165 pounds	4,950	"	
Tackle and blocks	125	"	7,325
Increase 22 percent			1,611
			8,936

Test load per arm $= \frac{8,936}{2} = 4,468$ pounds.

After the davits have been originally tested, the official annual inspection and the required lifeboat drills will insure that the davits are always in good running order.

Factory Test of Davits

There ought to be some universal method adopted for testing davits at the factory where they are built. The following method adopted by the manufacturers of the Welin quadrant davits is suggested: All the davit parts are carefully inspected before machining. The steel castings are tested for tensile strength, elongation and bending. They are all carefully annealed. The completed davit is bolted on a floor plate. The position of the eye on the fully swung in arm is determined by a plumb line. A test load 30 percent to 100 percent greater than the maximum service load is suspended directly from the eye and the arm is fully swung out. The test load is removed and the arm swung back. The arm is then plumbed again to see if there is any permanent deflection. The least sign can be detected in this way. The arm is passed if there is no permanent deflection, otherwise it is broken up and thus destroyed. Tackle and blocks are then hung in the eye and a test load of about the weight of the empty boat is hung on the tackle and block and the arm fully swung back and forth to determine that all the working parts are in first-class condition. The working of all the parts are thus tested for twice the actual load they ordinarily are subjected to when worked on board the ship.

Any method of this kind would give perfect confidence that the davits will work well and stand up when they are needed in the saving of human life.

Lloyd's Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping show that, excluding warships, there were 442 vessels of 1,506,923 gross tons under construction in the United Kingdom at the close of the quarter ended June 30. This is nearly 81,000 tons less than at the end of last quarter and about 215,000 tons less than the tonnage building twelve months ago.

A Record in Ship Construction.—By delivering the Bull steamer *Edith*, a steel ship 338 feet long by 5,000 tons deadweight capacity, in the short space of five months the Maryland Steel Company, Sparrows Point, Md., has established a record in shipbuilding. The keel for the ship was laid February 16, she was launched June 16, and delivered a month later.

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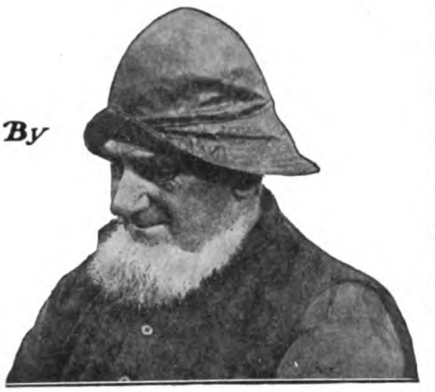
Economy Talks By "Old Scotch"



Why Brass is an Expensive Luxury in the Engine Room

Two or three months ago I served notice that I was going to continue my long-winded yarns on economy in general. I sure have the economy bug in my system and I want to inject that bug in some more marine engineers —so watch out that you don't get infected.

I think I warned you in one of my other talks to beware of brass in building machinery and in repairing it, for there is where the money flies. I well remember the first ship I ever sailed on. To look down into her engine room when it had just been cleaned up would nearly blind you. Polishing paste was bought by the crate, and about half the time in port was spent in shining things up. Handrails, handwheels, gage boards, bands around the lagging, oil feeders, oil drips, and about everything in sight except the cylinders, columns and rods were either made of brass or else ornamented with it.

Nowadays it is all changed. Seems to me that every new engine I look at has less and less copper and brass, and, after all, it is a mighty good thing from the engineering standpoint. Polished steel handrails are stronger than brass and look just as good when you get used to them. Russia iron lagging looks as good as walnut staves and brass bands, and costs a darned sight less. Cast steel eccentric straps are stronger and better than composition, and when they are lined with white metal are just as efficient. Malleable iron squirt cans may not be so gaudy as sheet brass cans, but you can squirt oil just as far and just as straight with them, and they only cost one-third as much. Of course there are some parts of the machinery where you can't avoid using some brass or copper, but they are growing fewer all the time.

Besides the original cost of the yellow stuff, did you ever notice all the trouble it gives you? If you put it in valves or pipes that are used around salt water you're up against it for sure. Our old friend "galvanic action," or electrolysis, as the highbrows calls it, gets in its work at once, and the first thing you know you're down on your belly or knees in the bilges wrapping some pipe to stop a leak. About an hour or so after you've stopped one leak, you're lucky if the oiler doesn't come up to you and report another pinhead leak in the same length of pipe. Then I'd hate to listen to your language. If you don't happen to put great quantities of zinc around your sea valves or in your condenser heads, then you find the cast iron or steel plates being eaten away.

Oh, I tell you this copper and brass business does make lots of trouble. Of course we still have to use it in our surface condensers, and that's half the cause of trouble in the boilers, as it is not content with chewing away the condenser heads, but it must needs "pizen" the feed water and start a row in the boiler inwards by setting up pitting on the unsuspecting plates. Brass in condenser tubes not only starts all kinds of fusses with iron or steel, but it soon starts a row in its own midst; the zinc fights with the copper, and the first thing you know the old condenser needs a new set of the trouble makers, and, believe me, that costs some money these days, with copper at 30 cents (1/3) a pound and zinc even more than that.

A fellow showed me a sample of condenser tubes made out of this new stuff called Monel metal the other day. You know that's about 60 percent nickel, and they say there's nothing much doing in the "eating away" business when it gets in contact with other metal. It costs over a dollar (4/2) a pound, but I think it would be economy in the end to use it even at that price, as it wouldn't have to be removed every three or four years like some of these brass tubes we are now using.

Copper fire mains, you all know, are another source of trouble. If they are not thoroughly drained, and very often they are not, the salt water remaining in them starts galvanic action, and the first thing you know it leaks like a sieve. One of the big shipyards thought they had solved the whole fire main difficulty by using extra heavy wrought iron pipe and lining it with lead expanded tightly in the pipe. As they say on the stage, that "listened very well." But on nearly every ship where these lead-lined pipes were fitted they have found that, in spite of all the pains they took to prevent it, the salt water would leak in between the lead and the iron around the flanges, and then it was good-bye iron pipe. You could almost hear the scrap going on between the lead and the iron, and the result has been leaky fire mains again. This same firm has now gone back to first principles and uses extra heavy wrought iron or steel pipes for their mains and has them heavily galvanized. They last longer than copper, are stronger, and you can bet very much cheaper. If any of you have any leaky copper fire mains to repair, I would advise you to sell the copper to the junkman and put galvanized iron piping in its place.

A prominent designing engineer once told me that any fool could build an engine with plenty of brass around it and make it run, but that it took a good man to use only iron or steel and build a successful engine. Judging from the way they get up recent marine engines, all the designers nowadays must be wise men, for I'm blamed if I have seen any of them recently where you can find enough brass in sight to make a pair of earrings for a Hottentot.

So, to close my remarks, I must repeat, that if you want to save money around marine work, "Cut out the brass, for it costeth like the dickens and troubleth all the time."

Yours for economy,

Old Scotch

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Four-Bladed vs. Three-Bladed Propeller

Q.—Will a four-bladed propeller of the same pitch and diameter as a three-bladed one do any more work?

A.—Operating at the same revolutions per minute, a four-bladed wheel should give about 12 to 15 percent more thrust.

Advantages of Open Rod Valve Gear

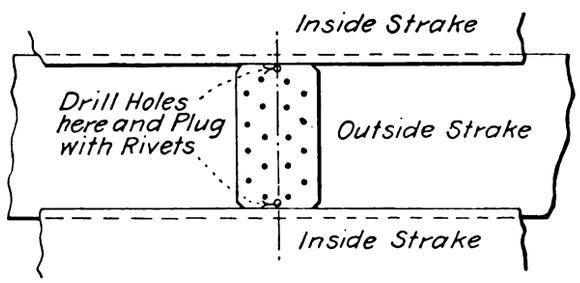
Q.—Will you please tell me why, with the ordinary Stephenson link valve gear which is used on marine engines, the open rod type is so much more common than the crossed rod? C. R.

A.—Where it is intended to operate the engines linked up to any considerable extent, the rods should be of the open type, as they permit of a greater range of expansion and less reduction of port opening than crossed rods.

Stop Waters for Single Strapped Butt Joints

Q.—Is there any special precaution taken with single strapped butts of outside strakes of shell plating in the nature of stop waters? C. S.

A.—Yes, they should be provided with stop waters. An excellent way is to drill a small hole at the end of the butt



Location of Stop Waters in Single-Strapped Butt Joint

between the plates and plug with rivets for stop waters, as shown in the sketch. So far as I know, this is the only practical way of making single strapped butts watertight.

Fitting Deck Beam Knees

Q.—Can you tell me if it is the custom in general merchant construction to erect the deck beam knees as part of the deck beams or as part of the frames? SHIP FITTER.

A.—Deck beam knees are frequently riveted to the deck beams previous to the erection of the beams. The knees should be punched with two frame holes only in each in accordance with the requirements of the classification societies' rules, the others being left to be drilled in place. Sometimes the knees are riveted to the frame first and the choice between the methods seems to be the handiness with which the riveting can be done. When the knees are attached to the beams, they usually are included in the contract made with the beam squad, but when attached to the frames it usually requires an independent contract.

* Associate Professor of Naval Architecture, Massachusetts Institute of Technology, Boston, Mass.

Correct Method of Counting Revolutions of Engine

Q.—I have had quite an argument with a brother engineer as to the proper way of counting the revolutions per minute of an engine under way. He holds his hand out and counts for a minute each time the crank touches his hand, beginning one, two, three, etc. I maintain that the first contact should not be counted and that he always gets one revolution per minute too many. Please tell me if I am right. DOG WATCH.

A.—You are right. An excellent way is to begin all counting with *zero*. This inaccuracy you mention is common and is often of appreciable importance in slow speed engines.

Effect of Varying Position of Compass on Board Ship

Q.—In discussing the steering qualities of vessels, one of my shipmates asserts that in ships where the pilot house (and steering gear) is placed forward or near the bow, the mariner's compass will respond slower to the turning of the ship, and consequently make the steering harder than it would be if the same compass and steering gear were placed in the after end near the stern. I contend that the movements of the compass would be identical whether it was placed near the bow, amidships or near the stern, neglecting, of course, any local attraction of the compass needle. Please decide who is right. H. W. S.

A.—You are right. The compass, aside from local attraction, is unaffected by variation in location aboard ship.

Formula for Estimating the Speed of a Boat

Q.—What must I know to tell how fast an engine will drive a boat without having seen the boat? I assume that I have all the information regarding the engine with the exception of the propeller.

I will appreciate greatly any assistance that you can give in regard to this subject, such as formulæ, etc. A. F. G., Jr.

A.—If the boat is not of the hydroplane type the following formula gives a fair approximation to the speed to be expected. This was published in an excellent article on this subject in *Motor Boating* of October, 1912, by H. H. W. Keith, and a reference to this article is desirable. For more complete discussion see "Propellers," by C. H. Peabody.

$$M = \frac{C \sqrt[3]{L \times P}}{B}.$$

Where M = speed in miles per hour.
L = length over all (feet).
B = beam, extreme (feet).
P = brake horsepower of engine.
C = constant = 9.5, moderate speed type.
= 8.5, high speed type.

Limitations of Heavy Oil Engines

Q.—As a reader of INTERNATIONAL MARINE ENGINEERING, I have become very much interested in the articles on heavy oil engines and have often wondered why engines of this type are not tried out on automobiles. The question I would like to ask is, Is this type of engine practicable for automobiles, and, if so, why are the makers not making experiments in this line? L. L. M.

A.—Heavy oil engines are of the Diesel or semi-Diesel type and operate upon cycles which involve the compression of the air charge to such a pressure that the temperature becomes high enough to ignite the fuel charge. This

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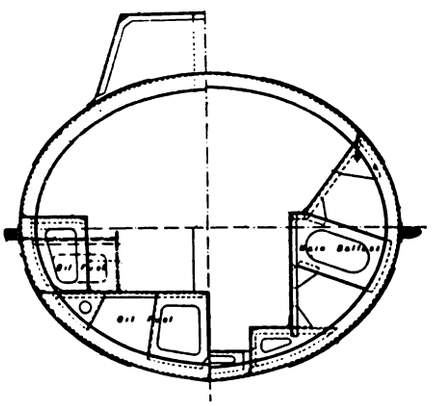
means added complication and weight to inject the fuel charge and perform other incidental operations so that the resultant engine is far too heavy to compete with the standard type of gasoline (petrol) engine for automobile work, and is also less simple.

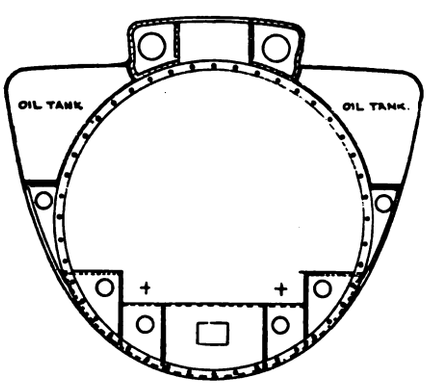
Submarines and Submersibles

Q.—Will pou please explain the difference between a submarine and a submersible? I see the terms used frequently in the papers and the activities of the two seem to be of the same sort. S. Q.

A.—The line between the two types of under water vessels cannot be sharply drawn, but in general if the condition of operation which has received greatest attention in the design is the under water one, the vessel is classed as a submarine. If, however, the surface operation has been considered the more important condition, the result



Midship Section of Submarine



Midship Section of Submersible

is the submersible. Usually the submersible has a ship-shaped external form and the submarine a cigar-shaped form. The submersible has practically a submarine form (circular cross section) incased in a ship-shaped form for better surface operation (see sketches). The submersible usually has greater surface speed than the submarine, but a less submerged speed and shorter allowable period of submergence.

Operation of a Steam Gage

Q.—Will you kindly explain to me why the tube which actuates the hand of an ordinary steam gage tends to straighten out when the pressure goes on? Would it be possible to straighten out the tube completely if we applied sufficient pressure? P. T.

A.—The Bourdon tube of the common steam gage has a transverse section which becomes distorted when pressure is applied. The tubes are frequently elliptical in section, and when pressure is applied the transverse sections tend to become circular in shape. This action results in moving the walls of the tube, which are normal to the face of the gage, away from each other. As the lengths of the outer and inner arcs of the tubes as a whole cannot change, this separation of the arcs results in an increased radius of curvature of the tube as a whole, as may be seen by the following elementary discussion.

Assume a tube of elliptical cross section bent around the small diameter of the ellipse into the arc of a circle. Let the radii of the arcs of the walls be r_1 and r_2 for the no pressure condition and R_1 and R_2 when subjected to pressure. Let t be the small diameter of the ellipse before, and T this diameter after, pressure is applied; then

$$t = r_1 - r_2 \text{ and } T = R_1 - R_2$$

$$\frac{R_1 - R_2}{r_1 - r_2} = \frac{T}{t} \qquad (1)$$

The lengths of the arcs of the tube walls before pressure is applied are $K r_1$ and $K r_2$ for the outer and inner walls

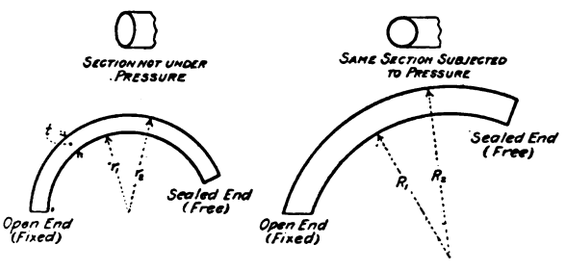


Diagram Showing Action of Bourdon Tube

respectively, where K is a constant. These lengths remain constant when pressure is applied, so that

$$K r_1 = K^1 R_1 \text{ and } K r_2 = K^1 R_2$$

Subtracting

$$K (r_1 - r_2) = K^1 (R_1 - R_2)$$

and

$$\frac{K}{K^1} = \frac{R_1 - R_2}{r_1 - r_2} \qquad (2)$$

equating (1) and (2) we have

$$\frac{K}{K^1} = \frac{T}{t}$$

therefore

$$R_1 = \frac{K}{K^1} r_1 = \frac{T}{t} r_1$$

and

$$R_2 = \frac{K}{K^1} r_2 = \frac{T}{t} r_2$$

which means that the new radius of curvature of the tube as a whole is equal to the old radius multiplied by the ratio of the new over the old small diameter of the transverse section of the tube. The limit of straightening effect is reached when the transverse section becomes circular.

Position of Air Vent Cocks in Feed Water Heaters

Q.—Please tell me why the makers fit air vent cocks near the *bottom* of the steam space in feed water heaters. H. P.

A.—Saturated steam has a temperature corresponding to its pressure. If air is mixed with the steam, it has a temperature probably the same as that of the steam. For a given pressure and at the temperature corresponding to that of saturated steam, air has a greater density than steam (1.62 at 60 degrees and .25 pound absolute to 1.41 at 434 degrees and 358 pounds absolute), and therefore falls to the bottom of the steam space. Air is a good thermal insulator and its removal is very desirable to permit all tubes of the heater to do their proper work.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

The First Electrically Propelled Submarine Vessel

In the article on "Submarines," by Mr. Simon Lake, in the July issue, reference is made to the electrically-propelled submarine vessel which I invented, built and demonstrated at Liverpool in 1886. As only meagre details of this craft are given, I wish to call attention to the leading features of the vessel.

In the first place, what Mr. Lake terms down-haul screws *were not* used for submerging when under way, but were connected to a pendulum and were stationary so long as the boat was on an even keel, but were brought into action in connection with the after horizontal rudders when the boat deviated from a level plane, so as to bring it back automatically to an even keel. I then considered, and still consider, any deviation from an even keel dangerous when submerged. This, I think, has been proven, with unfortunate loss of life.

These propellers in vertical tubes could be used to submerge the vessel when stationary and in "awash trim." For submerging the vessel when underway I used a pair of horizontally balanced side rudders or inclinable water planes placed amidships. By regulating the angle of these the vessel was raised or lowered in the water. I never destroyed all the reserve buoyancy.

Two locomotive "fish" torpedoes were carried, one on each side above the side rudders, and secured to the vessel by grips which were operated by a lever inside the vessel, releasing the torpedo and starting its propelling power, so that it shot ahead of the vessel. This did away with the use of torpedo tubes and their complications.

This submarine was only 37 feet long, with a displacement of 15 tons, the intention being to carry it on board a war vessel and to work from that craft as a base. The accumulator, or electric storage cells, were to be recharged by the vessel's dynamos.

I claim to be the originator of the following features as applied to submerged vessels:

First.—That this was the first electrically propelled submarine vessel.

Second.—The use of horizontal balanced rudders placed amidships.

Third.—Vertical propellers in tubes through the vessel for keeping the vessel on an even keel or submerging when stationary.

Fourth.—The method of carrying and discharging "fish" torpedoes.

Fifth.—The adaptation of a submarine so that it could be carried by, and work from, a war vessel or other craft as its base.

With regard to Mr. Lake's statement, that I did not further develop submarines, I had produced a practicable submarine, *the first* to be propelled by electrical power derived from accumulator cells, which all recent submarines have copied. In fact, a Government inspector of submarines recently told me that I had in 1886 used various appliances that are now the cherished patents of various submarine companies. As stated by Mr. Lake, no government (except the Turkish) actually purchased any submarines until many years after I first brought mine to their notice. In the meantime I had become disgusted and left the field open to those who, with more capital, could make money by improving upon the inventions of others.

Riverton, N. J. J. F. Waddington.

Accident to a Condenser

While the engineer of a menhaden fishing steamer was getting ready to turn the engines over at the dock a peculiar and unusual accident occurred to the condenser. The engines were of the fore and aft compound type, with surface condenser built in as part of the frame. The air pump was independent, of the simplex type, and had been running for a short time previous to the accident. It stopped of its own accord and no one noticed the stoppage for some time, during which interval steam was blowing through the cylinder of the air pump into the condenser, into which the centrifugal circulating pump was also exhausting.

When the engineer discovered that the air pump was not running he went below and started it, then returned to the upper grating and opened the throttle on the reversing ram. Instantly there was a loud report, and on going below the back side of the shell of the condenser was found badly cracked in several places. These cracks extended almost the entire length of the condenser, one at the bottom, one at the center, and one near the top, with smaller cracks radiating from these. The throttle valve on the engines was tightly closed and the stop valve on the boiler merely cracked off the seat, with the steam-pipe drain open to the bilge, so that there could not have been any steam pressure in the condenser.

The only plausible explanation of this accident was that while the air pump was stopped water accumulated in the condenser from the condensation of the steam that was blowing through the cylinder of the air pump, also of the exhaust steam from the circulating pump. When the engineer opened the throttle of the reversing ram the air pump had not exhausted the condenser and the sudden inrush of steam from the reversing ram caused water hammer, which cracked the cast iron shell of the condenser.

It was at first thought it would be necessary to replace the damaged condenser with a new one, but this would have entailed considerable expense, it being necessary to take out the entire engine, with the exception of the bedplate and crank-shaft, as well as removing part of the deck house, in order to get the old condenser out and the new one in. There would also have been a delay of from six weeks to two months, a matter of serious importance, the fishing season being short, and it was finally decided to repair the old condenser by patching it.

The tubes and tube sheets were removed and two patches, made of 3/8-inch boiler plate, fitted on the inside of the condenser, covering the entire back side and flanged on top and bottom. These patches were fitted

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after the broken parts were forced back into place, joined with red lead putty, and riveted on, care being taken that rivets were placed along both sides of all cracks to insure the patches being drawn tightly to the cracked places. The repairs were completed in ten days, and the condenser was absolutely tight under test and fully as strong as it was originally.

Had this condenser been fitted with a relief valve—one which would close with vacuum in the condenser and open when water accumulated—this accident could not have occurred.

New London, Conn. J. S.

Duplex Pumps

In a previous article (December, 1912) in this journal the writer dealt with setting the valves and testing this type of pump. He is still convinced from subsequent experience that this auxiliary is abused more from ignorance than from any defect in the pump itself. A duplex pump does not profess to shift water at a minimum of cost except under water works conditions—i. e., watertube boilers, triple expansion steam ends, Corliss valves and the refinements possible to a large and costly plant.

The ordinary duplex pump, however, is probably the cheapest form of water shifter extant. The capital cost per unit, say 100,000 gallons, pumped is lower. It starts, even if in poor condition, by the simple opening of steam to the pump. Pumping is, of course, "collar" work all the time; it is a dead steady load with no easing up. In addition, the duplex occupies less space for its capacity than any other form of reciprocating pump, rarely requires priming, and will actually pump water when in a shape and repair that would put most others out of commission. It may not be exactly the most economical, but has advantages which give it a wide application where economy is not an absolute consideration of prime importance, it is to be found working in a most satisfactory manner under the charge of inexpert labor.

The inventor of the Willans engine, one of the prettiest prime movers ever built, used to say that he preferred a gardener to an engineer to run an electric light plant having his engine. The gardener would be satisfied to open the stop valve, and so long as the job went round never interfered with its interior economy. The engineer, on the other hand, would display the curiosity inherent to his craft and would, in attempting to make adjustments and by dismantling and overhauling, put the engine out of commission. The duplex pump is another case in which the same remarks can apply with sufficient truth to make them "hits." The makers of this type of pump, without exception, put each pump made on the test bed, run them under steam and adjust them to give the best results. The engineer into whose hands a new duplex comes has only to pack the glands and connect up water and steam. Often, not satisfied with these simple matters, he opens up the pump and, from curiosity, experiments, to the undoing of the pump.

Some mechanical appliances, unless duly set and this to a nicety, will refuse duty altogether. The duplex pump, however, struggles gamely on under very adverse conditions, only expiring under protest if the injury is very severe. One mistake so common as to be almost universal is to allow no lost motion when setting the valves. Another is, in a vain attempt to get increased delivery, to pack the water pistons too tightly.

Having previously dealt with the setting of the valves and testing of a duplex pump, it has occurred to me that some further information on the subject of locating trouble when experienced with the duplex pump would prove helpful.

The following is in no sense a recapitulation of the previous article, but should be read in connection therewith, although, of course, it in no sense depends upon it.

Testing Pumps

A steam pressure gage must be fitted to the steam chest cover and a water pressure gage with regulating cock on the delivery side of pump, also a stop valve is needed to the delivery pipe from pump. The covers of both ends are usually provided with screwed holes for lubricators (which, by the way, are rarely in evidence, although supplied in every instance to a new pump).

In testing a boiler feed pump with everything in order and with steam pressure of, say, 40 pounds, it should be possible to obtain a full bore delivery pipe when delivering against an equal water pressure. The pressure on the water end gage is obtained by the regulation of the stop valve, and the discharge of water should be visible. With equal steam and water pressures the gage pointer on the water gage should be reasonably steady.

If the supply of water stops while the pump is running, it can usually be traced to the fact that the water pistons or plungers are letting by, or else that suction valves are leaky.

If the pump works erratically and the gage pointer shows violent pulsations the trouble may be traced to one or more leaky suction valves.

To Test for Leakage Through the Water Valves

Throttle down the delivery stop valve until the pump is running six to eight double strokes per minute. Care must be taken that the water pressure does not exceed what the casting is designed for (in boiler feed pumps this is usually 160 pounds). Adjust the steam valve to keep water within safe limits. Watch carefully each stroke; if one of the water pistons travels suddenly to the end of the cylinder, the suction valve on that end will most probably be the leaky one, the reason being that the water, instead of being forced through delivery valves against pressure, takes the line of least resistance through the leaky suction valve.

Other Causes of Erratic Working

(*a*) *Loose Water or Steam Piston.*—Loose pistons cause erratic behavior and bad knocking. Carefully check so that piston rod nuts tighten on to pistons and do not be misled by tight nuts.

(*b*) *Broken Joint Beneath Force Plate.*—This would cause gage fluctuations similar to those caused by leaky suction valves. This is a very common fault.

(*c*) *Broken Steam Cylinder Cover Joint Between the Two Steam Cylinders.*—This allows steam to be on back of both steam pistons at the same time, causing erratic working and slowing up of pumps, another very common trouble. In making new joints take care that the material is not too hard (ordinary millboard makes good water joints) and see that bolt holes are a good fit to the bolts. Take care in force plate and steam cylinder head joints that the castings are not hollow, and that the divisions between the cylinders in the case of steam cylinder head joints and the divisions between the valve chambers in the case of force plate joints are of ample width.

To Investigate a Troublesome Pump

When starting, carefully check the water pressure before doing anything else. It is not uncommon that the

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boiler feed pipe, either inside or just outside the boiler, is "furred up." This "furring up" may reduce the area of the pipe sufficiently to throw excessive pressure on the water end against which pump cannot drive with sufficient speed to deliver enough water.

Duplex pumps and pumps in general fitted for boiler feeding are frequently blamed when the trouble exists in the piping and connections.

Another source of trouble is a *throttled suction pipe*, caused in some instances by lining up. This gives a decided cushioning effect on the pistons at one or both ends of the stroke.

A further cause having a like effect would be a *throttled exhaust*. To determine this note the number of strokes per minute before disturbing connections, and again with exhaust open to atmosphere; if a gain in speed is obtained, the trouble is in the exhaust pipe and not in the pump. Should, however, the trouble be in the pump, the cause should be looked for in the exhaust port of the slide valve, which will be found not to travel central across the exhaust ports and cylinder, causing back pressure on exhaust side of steam pistons.

Leaky Steam Piston Rings

These would also cause the pistons to be cushioned. To ascertain whether piston rings are steam tight, throttle down water pressure to slow up speed of pump. Then open up each drain cock on the cylinders in turn and watch carefully that there is a clean cut-off with the steam. If not, it shows that leakage is taking place either by the steam piston rings or else the slide valve.

Steam Piston Rings

These should be a free floating fit between the steam piston body and the follower.

Fitting New Steam Piston Rings to Cylinders

With the piston on the rod and ring in position, work the piston along the cylinders several times sharply; an examination of the ring will then show whether they have an efficient bearing.

To Test the Cylinder Bore

Place the steam piston ring only in the middle of the cylinder with its joint at the bottom. It should not be possible to pass a 4/1000 inch feeler between the ring and wall of the cylinder at any point.

Water Valves

These should be a free fit on the valve guard stem. There should be at least 1/16 inch clearance between valve and valve guard stem to insure that lime or sediment which forms on them shall not interfere with the free lift of valve. See that the center and outside faces are both perfectly flat with one another. If the center face is hollow, leakage takes place between the valve and stem.

Valve Seats

See that these are perfectly flat, and also that the top thread in center of seat is cut away. Otherwise the top thread may be pulled out when guard is screwed home and prevent the valve seating properly. In old pumps examine the outside of seat for corrosion. This would possibly lead to loose valve seat unless precautions are taken.

Slide Valves

This should be carefully checked. The length should just cover the ports. There is neither external nor internal lap. See that exhaust, cushion and steam ports are in a line with one another. See that valve port in valve is of correct length, and that it works centrally over the ports in cylinder, otherwise a throttled exhaust and consequent loss of speed will result.

Water Pistons

Make sure that these are not too slack in the liners. They should not be more than 1/16 inch small, otherwise trouble, especially in the smaller sizes of pumps, may arise, due to washing out of packing. In the fitting of packing to the water pistons measure the packing space available, measure packing before using, and allow 1/16 inch for the packing to expand sidewise. If necessary, reduce the size of packing by stripping layers to obtain this result. Also do not let the ends of turns of packing butt; 1/8 inch should be allowed for expansion in this direction. See that packing is not too tight a fit internally and externally. To render hard packing pliable it can be softened by soaking in boiling water for a few minutes.

Piston Rods

Both steam and water pistons should be tried on rods before being placed in the pump. See that the tapers on the rods are a good fit to the pistons. Make sure that there is sufficient thread on the piston rods, that the nuts shall properly jam home on the follower. Make certain that the nuts are not too tight, as it is difficult to ascertain when in the pump cylinder whether the nuts bed properly on the pistons.

Levers and Spools

The jaws of spools must be machined or filed out perfectly square with one another and the lever must be a perfect rolling fit at any portion of the stroke. See that the end of lever is perfectly circular and that edges are quite square. A defective fitting lever results in the spool twisting out of position. A loose lever results in shocks to the valve gear and speedily causes slack motion pins and links.

The foregoing fairly exhausts the usual and some of the unusual faults and troubles incidental to the duplex pump. Some of the hints and dont's may seem unnecessary and trivial, but each is the result of special experience and all have value.

Beyond mentioning the duplex pump in a casual way, no text-book, it is believed, devotes very much attention to the subject. Certainly nothing known to the writer gives any hints as to the usual troubles experienced.

Hard cases may make bad law, but locating trouble in a mechanical sense provides good experience. To the engineer economy is not merely an incidental item, but is the prime factor in his existence. Auxiliary machinery runs away with more coal than is usually credited, while the condition and upkeep of these minor steam users can be, and should be, studied.

It is hoped that sufficient material is here set forth, together with the former article, to show how to locate and eliminate most of the difficulties and also to provide for complete overhauling of the pumps in question with certainty and ease.

London. A. L. Haas.

Tank Ship Sebastian Equipped with Werkspoor Engines.—The two 800 brake horsepower, two-cycle Diesel engines, installed on the tank ship *Sebastian* when she was built, have been removed because of their unsatisfactory working and are being replaced with Werkspoor four-cycle Diesel engines.

Canadian Shipbuilding.—During 1914 a total of 43,346 tons of shipping was built in Canada, the largest annual output from this country in fourteen years.

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Marine Articles in the Engineering Press

Problems Relating to Ship and Machinery Design—Model Experiments for Stability of Submarines—Lubrication of Journal Bearings

Destruction of German and Austrian Ships in Antwerp.—An account is given of the damage by explosions to German and Austrian shipping caught by the European war in the harbor of Antwerp. The hulls of the vessels were little damaged, only one ship being sunk, but of the thirty-six steamers, twenty-eight had their machinery damaged. The damage is stated to be almost exclusively in the cylinders, piping, main stop valves and columns, produced by cartridges hung to the outside of the parts. The damage is quite considerable, but the German author expresses surprise that the explosives were not applied internally in the engines and also in the boilers, due probably to the haste of evacuation of the fortress. 2 illustrations. 2,900 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* May 8.

Calculation of the Top Girder of a Suction Dredge.—The author discusses the problem of how to proportion the top girder on the centerline of the ship which by chains holds the bottom doors of the hopper compartments of a suction dredge. He considers the case as one of a longitudinal girder, supported upon two rigid end bulkheads and upon seven elastic and flexible transverse beams. The method employed is stated to be a graphical one as proposed by Ritter and described for bridges. It is also considered valuable for shipbuilding calculations, where many similar problems present themselves. Its principle is to find for every beam and for every piece of a beam the elastic weight and the limit of elasticity. The author carries through the calculations necessary for the completion of the graphical diagram, describing all the steps taken for an actual case with a top girder about 53 feet long. 6 illustrations. 4,600 words.—*Schiffbau,* June 9.

A Basis for Rational Design of Heat Transfer Apparatus.—By E. E. Wilson. The results of tests of heat transfer apparatus have been so inconsistent that the formulation of rational basis for design has been precluded. This lack of agreement leads to the conclusion that some variable has been neglected, and a study of the results of tests on feed-water heaters and condensers leads to the belief that this variable is the viscosity of the circulating water. Since the accepted law for heat transfer is of the same general form as that for the resistance to flow in pipes, it seems likely that there is some close relation. It also seems probable that the effect of viscosity is of the same general character in each case, and on this assumption the published results for heat transfer are corrected in the same manner as are the results of Osborne Reynolds' work on the resistance in pipes to flow of water through them. With this correction the results are reconciled, not only in an individual case, but for different experimentors as well. If, now, these results as corrected are put in the form of resistances to heat transfer, a linear relation is found to exist between the resistance and the reciprocal of the water velocity. The correction for viscosity may be put in this same form as a function of temperature. The resistance may then be evaluated in terms of its component parts and reduced to the form of an equivalent film of water of known thickness. These linear expressions may now be incorporated in a form giving the area of the heating surface required to transmit a given quantity of heat under the given flow conditions, in a condenser or feed water heater. This expression seems rational in form and applicable throughout the range of practice, and in addition it seems possible through the use of the relations established to determine by experiment a similar expression for the resistance to heat transfer in other types of apparatus. 10 illustrations. 8,500 words.—*Transactions of the American Society of Mechanical Engineers,* June.

U. S. S. Balch: Contract Trial Performance.—By Henderson B. Gregory. The *Balch* is one of the eight destroyers authorized by Congress March 4, 1911, and is a sister ship of the *Aylwin, Parker* and *Benham,* all four vessels being built under contract by William Cramp & Sons Ship & Engine Company, Philadelphia, Pa., at a price of $756,100 (£155,000) each. The *Balch* is a twin screw vessel fitted with a combination of Cramp-Zoelly turbines and reciprocating engines, one of each on each shaft developing altogether 16,000 shaft horsepower and designed to give the vessel a speed of 29.5 knots at about 1,036 tons displacement. For speeds of 17 knots and above the turbines alone are used, and for the lower cruising speeds reciprocating engines are used in combination with the turbines. Steam is supplied by four oil-burning White-Forster watertube boilers arranged in pairs in two separate compartments. The hull is 300 feet long on the waterline and 30 feet 4 inches beam at the waterline, with a draft of 9 feet 2½ inches to the load waterline. The block coefficient is .415. The trial data obtained on her official trials are given in tabulated form. and also revolutions, speed and power curves are plotted. At the highest speed, the contract speed of 29.5 knots was slightly exceeded, but the fuel oil consumption was in excess of that guaranteed. 1 illustration. 3,000 words.—*Journal of the American Society of Naval Engineers,* May.

On the Laws of Lubrication of Journal Bearings.—By M. D. Hersey. In order to establish a rational basis for bearing design, it would be desirable to have empirical equations, or curves, showing accurately and completely how the friction loss and load-carrying power of bearings depend on all the physical conditions governing the action of lubrication, including, of course, the size, shape and fit of the bearing, the speed, degree of lubrication, properties of the lubricant, and characteristics of the cooling system. The problem of mapping out the laws of lubrication in this general way, whether by piecing together existing data or by making new experiments, is such a complicated one that it is worth while to stop and consider whether any general principles are available which may serve to simplify it. A recognition of the above facts has led to the present paper, the object of which is first to reduce the problem to a physical basis by suitable definitions and restrictions, and then to develop certain general relations which will simplify the solution of the problem. These relations are of two sorts and may be summarized as follows:

a. The general forms of the laws of lubrication are deduced by dimensional reasoning. and the properties of dynamically similar bearings are discussed.

b. A distinction is pointed out between the "characteristic"—i. e., purely dynamical equations—and the "working" equations needed in the final design of a bearing. It is then shown that the dynamical characteristics of the bearing, and the thermal characteristics of the lubricant

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and the cooling system are three independent parts of the problem which may be separately investigated, thus greatly diminishing the number of combinations of conditions needed for mapping out the laws of lubrication over the full range of all the variables involved. Finally, a general method has been outlined for deducing the desired working equations by utilizing the results of these three investigations.

The paper closes with an analysis of the "ideal bearing" —i. e., one which is perfectly circular in cross section, etc. In this connection Sommerfeld's results are reproduced in a convenient form for practical use, and extended by a treatment of heating effects. While intended primarily as a particular illustration of the foregoing general relations, the equations and curves of the ideal bearing doubtless afford a first approximation to the laws of lubrication of actual bearings. 9 illustrations. 12,800 words.—*Transactions of the American Society of Mechanical Engineers,* June.

Influence of Disk Friction on Turbine Pump Design.—By F. zur Nedden. The mathematical survey of the problem leads to these conditions for a minimum loss through disk friction: (*a*) Smoothness (polish) of both disk and casing. Roughness of either is equally detrimental. (*b*) Smallest possible surface of both. Excessive extension of surface is equally detrimental whether it is the surface of the disk or of the casing. (*c*) Outward indication of attainment of minimum is the fact that the waste water rotates half as fast as impeller. A gyrostatic pressure is generated by the rotation of the waste water and added to static pressure prevailing at the center of the impeller. From the influence of the width of the impeller it follows that it is important to keep the thickness of metal at the periphery as small as possible. Protruding rims are objectionable. The influence of the ordinary roughness of nonmachined castings has no perceptible effect on the efficiency except with high lift pumps. Painting or japanning the surfaces generally seems less desirable than machining them with a medium heavy cut. High polish seems wasted. The experiments verify conclusions of mathematical survey. The influence of viscosity is proportional to its fifth root; yet it is responsible for an improvement in the efficiency of hot water turbine pumps. The effect of pumping heavy oil and tarry liquid is estimated. The influence of fluid density is almost exactly proportional to the specific gravity. The loss through disk friction constitutes a constant percentage of the normal useful power at all speeds in one and the same pump. Generally its percentic value grows with the value of $\frac{\text{head per stage}}{\text{capacity}}$ at constant speed, and diminishes with increasing speed and constant ratio $\frac{\text{head per stage}}{\text{capacity}}$. High heads are more economically produced by high speeds or a greater number of stages than by increasing the diameter of the impellers, but the number of stages should be left to the discretion of the makers, not fixed by specifications. A steep angle between impeller blades and the tangent at the periphery serves very considerably to improve the efficiency owing to indirect reduction in disk friction losses, especially in high lift pumps. The disk friction reaches a minimum for a certain width of the waste water chamber, which is about ⅜ inch for disks of 12 inches diameter. The increase with increasing width is due: (*a*) To the increase in retarding surface. (*b*) To the induction of secondary or induced hydraulic currents. Concentric ribs are advantageous, radial ribs are detrimental. In single-stage pumps the rotation of the waste water reduces the tendency for leakage by about 20 to 35 percent. In multistage pumps the same influence may even increase the leakage. Inequality in shape or roughness of the waste water chambers on both sides of the impellers produce a gyrostatic axial thrust due to disk friction which can assume very considerable values. The direction of this thrust is indicated by the rule: "The impeller is drawn to the side where the waste water rotates fastest." 12 illustrations. 18,000 words.—*Transactions of the American Society of Mechanical Engineers,* June.

Experimental Methods of the German Government Model Tank, Berlin.—To fully determine all the factors of resistance of a model ship, the author considers it desirable to make runs with the bare hull without propeller, aside from those of the hull with the propeller and from those with the propeller independently of the hull. There is given a full list of the denominations used and of the formulas employed for the final values. In the first two chapters the runs are carried through for a small 4,325-ton cruiser, and the results tabulated as well as the principal final values, illustrated in diagrams. In the second chapter of runs of hull with propeller are also entered the factors which race-augment and wake-gain have upon the propulsive coefficient. In the third chapter examples are given for tugs or vessels loaded by towing pulls; in one case for a single screw vessel with three different towing pulls, and correspondingly also for a twin screw vessel. 14 diagrams, 5 tables. 6,400 words.—*Schiffbau,* May 12 and 26.

The Surface Condenser (Modern Theory and Practice).—By C. F. Braun. The importance of the surface condenser in modern steam power plants warrants more careful consideration of design than is usually given. The functions of a surface condenser are to reduce the back pressure on the prime mover, return to the boiler the water of condensation as a chemically pure feed, return to the cycle as many heat units as possible, and remove from the feed water air in solution. The four separate fluids handled should approach conditions as follows: Steam should distribute in the condenser with minimum friction, be reduced to minimum temperature, and be converted into water for easy removal. Air, a slow conductor of heat, should be cleared from heating surfaces, freed from water vapor, and reduced to minimum temperature. Condensate should be cleared from heating surfaces, freed from air, and delivered at maximum temperature. Circulating water should pass with minimum friction, deposit minimum scale, and absorb maximum heat. The main factor effecting these results is heat transfer through the surface, which is proportional to the logarithmic mean temperature difference. The resistance to heat transfer may be divided into that on water side of tube, that of tube, and that on steam side of tube. If analyzed in this manner, Orrok's results previously published show straight line relation between heat transfer from water to tube to velocity according to following equation:

$$U_w = 245 + 141\,V.$$

Attention in design should be given to all of these factors, and a comprehensive rating should include the following: (*a*) Quantity of steam condensed, (*b*) vacuum obtainable (corrected to 30 inches barometer), (*c*) temperature available cooling water, (*d*) cooling water exit temperature, (*e*) condition of air at point of removal, (*f*) friction head on cooling water, (*g*) temperature of condensate at point of removal. 17 illustrations. 8,000 words. —*Transactions of the American Society of Mechanical Engineers,* June.

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New Books for the Marine Engineer's Library

Practical Guides to Board of Trade Examinations for Marine Engineers' Certificates—Data Regarding Northern Pacific Ports

ELEMENTARIES, VERBALS AND DRAWING FOR MARINE ENGINEERS. (Part II of Griffin's new Guide to the Board of Trade Examinations for First and Second-Class Engineers.) By R. A. McMillan, B. Sc., Wh. Ex. Size, 5½ by 8½ inches. Pages, 323. 300 illustrations. London, 1914: Charles Griffin & Company. Ltd. Philadelphia, 1914: J. B. Lippincott Company. Price, $3.00 net.

The primary object of this book is to provide instruction which will enable marine engineers to pass the Board of Trade examinations for second and first class engineers' certificates. There are many engineers who have not had the opportunity of gaining any experience in the working and management of refrigerating machinery, steam turbines or oil engines, and others who have only an imperfect knowledge of the use of the indicator, indicator diagrams and the adjustment of slide valves. A working knowledge of such matters cannot be acquired wholly from books, but, with the aid of a good book on such subjects and some practical experience, an engineer will find that he can accomplish much more and become more efficient in handling marine machinery with results which are likely to lead to his further advancement.

The book includes sections on the slide valve, the indicator and indicator cards, the marine steam turbine, electric lighting, refrigerating machinery and oil motors. Over 100 pages of elementary questions for first and second class engineers are given, together with complete answers to the questions. About 25 other pages contain verbal questions and answers on marine boilers, indicator cards, shafting, propellers, condensers, pumps, the slide valve, etc. Thirty drawings of marine engineering details, such as are required at Board of Trade examinations, are also given, together with instructions for answering the questions commonly asked in connection with the drawings.

The book is a thoroughly practical guide for those who are taking up the profession of marine engineering, and will be found a most useful aid for advancement in this profession. In recent years there has been a steady increase in the amount of scientific knowledge required of seagoing engineers, and new inventions and developments are continually changing the nature of the work for which chief engineers on board ship are responsible. Under such conditions the fundamentals must be thoroughly understood, and for acquiring such knowledge this book will be found very useful.

THE MARINE MOTOR. By Frank W. Sterling. Size, 4½ by 7 inches. Pages, 136. Illustrations, 52. New York, 1915: Outing Publishing Company. Price, 70 cents net.

To the novice who is unfamiliar with the construction and operation of marine gasoline (petrol) engines, this book will prove a valuable aid in overcoming difficulties in mastering the details of a marine motor and in operating it successfully.

NAVAL RECOGNITION BOOK. By Fred T. Jane. Size, 5 by 7¼ inches. Pages, 63. Numerous illustrations. London, 1914: Sampson, Low, Marston Company, Ltd. Price, 1 shilling net.

In Jane's "Fighting Ships" several pages are devoted to silhouettes of typical naval vessels, so that by reference to these silhouettes the ships can be identified at a distance at sea. In this volume silhouettes are given of representative ships in each class of naval vessels in the British navy. A complete list of the vessels in the British navy is given, with particulars as to tonnage, speed and armament. The book is of handy pocket size and should prove a convenient aid for navigators at sea.

PRACTICAL MATHEMATICS FOR YOUNG ENGINEERS. By E. Hovenden. Size, 5 by 7½ inches. Pages, 144. Illustrations, 25. Glasgow, 1914: James Munro & Company, Ltd. New York, 1914: D. Van Nostrand & Company. Price, $1.00 net.

From his work as principal of the Marine Engineers' Training College, Cardiff, the author is thoroughly acquainted with the requirements of practical draftsmen and mechanics, and for such men the contents of the book have been specially arranged to form a sound groundwork for the special knowledge necessary to obtain a Board of Trade certificate as a marine engineer. Many of the examples given in the book are taken from Board of Trade examination papers. The book covers the practical application of mathematics to simple problems in mechanics.

MECHANICS FOR MARINE ENGINEERS. By A. N. Somerscales. Size, 4½ by 7¼ inches. Pages, 277. Glasgow, 1914: James Munro & Company, Ltd.; New York, 1914: D. Van Nostrand & Company. Price, $1.50 net.

The subject matter in this book comprises a series of lessons in mechanics for marine engineers and engineering students, treated arithmetically, with numerous diagrams. Each lesson is first fully explained; then the rules applying to the particular lesson are given with examples worked out showing complete calculations for solving the problems. Finally, at the end of each lesson problems are given, together with the answers, but without the calculations, leaving it to the student to apply the knowledge gained in studying the lesson for the solution of the problems.

TERMINAL FACILITIES OF NORTH PACIFIC PORTS. Size, 5 by 6¾ inches. Pages, 336. Seattle, Wash., 1914: Terminal Publishing Company. Price, $2 net.

Regulations covering the principal ports of the North Pacific from San Diego on the south to Nome on the north, together with the charges that are assessed against either ships or cargoes, are given in full in this book, together with the names and addresses of government officials, foreign consuls and others whose names and addresses are of value to masters and shippers. One section is devoted to the depth of water in all the bays and inlets on the United States Coast, and customs, marine insurance and immigration regulations are set forth in detail. The book is designed as an annual publication and covers very thoroughly the terminal facilities of the North Pacific ports of the United States.

BUSINESS ADMINISTRATION. By Edward D. Jones. Size, 5 by 7½ inches. Pages, 275. New York, 1914: The Engineering Magazine Company. Price, $2.

By a study of the older professions of war, statecraft and science, Professor Jones has sought to establish the scientific principles of the newer profession of the administration of maufacturing and operating companies. From the data compiled in this study definite primary principles of administration have been analyzed. The administrator is considered as a leader of men more than as a trustee of properties. No special doctrine or practice of management is advanced, but the treatment of the subject tends to bring administration to the high plane occupied by the older professions and serves to stimulate and direct the ideas of those who have made this profession their life-work.

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Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The most successful company in the United States operating vessels in the trans-oceanic trade, and owning probably more such vessels than any other company—we refer to the Standard Oil Company—shows its confidence in the future of the American merchant marine by having under contract four extra large tank steamships with the New York Shipbuilding Company and three with the Newport News Shipbuilding & Dry Dock Company. The tonnage of tank steamships now under construction or contract in the seacoast shipyards amounts to over 200,000 tons, of which vessels aggregating 88,000 tons are for the Standard Oil Company.

Shipbuilding is apparently the only branch of engineering on the Atlantic Coast that is running 100 percent capacity without a trace of so-called war orders. What is more important, there is every assurance that this 100 percent capacity will continue for at least five years to come.

There has probably been no time in the history of the world when so many vessels were in need of repairs as at the present. The requisitioning of dry-dock facilities in Europe for naval purposes is driving mercantile shipping to this country for repair work, with the result that never before have the dry-dock companies of America enjoyed such a rush of business.

Recent Orders for New Ships

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Gulf Refining Company, Pittsburgh, Pa., for two oil-tank steamships, one of very large size and the other of medium size.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Munson Steamship Line, New York, to build a steamship to cost about $400,000 (£82,000).

The Welin Marine Equipment Company, Long Island City, N. Y., has received a contract from the Quartermasters Department, U. S. Army, Washington, D. C., to build twelve Lundin motor lifeboats of the housed-in type, each 30 feet long.

Percy & Small, Bath, Me., are about to lay the keel for a large schooner.

The Merritt & Chapman Derrick & Wrecking Company, New York, will have a steel derrick lighter built, to be about 135 feet long.

The Union Iron Works, San Francisco, Cal., has received a contract from the Union Oil Company, San Francisco, to build an oil tank steamer to cost about $1,000,000 (£205,000).

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, to build a steamship to be about 450 feet long.

The Baltimore Dry Dock & Shipbuilding Company, has received a contract from the Trans-Atlantic Motor Ship Company, Ltd., Christiania, Norway, to build two large schooners to be equipped with Bolinders oil engines.

The Newport News Shipbuilding & Dry Dock Company has received a contract from the marine department of the Standard Oil Company, New York, to repair its steamer *Standard*, which was recently damaged by fire.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract to cut in two four steamers of the Erie Railroad Great Lakes fleet before transfer to the purchaser, the Staten Island Shipbuilding Company, Port Richmond, N. Y. The contract price for the work is about $60,000 (£12,300).

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract to build a 750-ton submarine for the Spanish government.

The Elco Company, Bayonne, N. J., are building 500 70-foot launches for the British government, and it is reported that the Standard Motor Construction Company, of Bayonne, N. J., will build the 8-cylinder motors of 380 horsepower required for these launches, at a contract price stated to be $5,000,000 (£1,025,000).

Shipbuilding Contracts Pending

The Ocean Steamship Company (Savannah Line), New York, opened bids recently for two ships, but it is understood that contracts have not yet been placed.

It is stated that Libby, McNeil & Libby, Honolulu, T. H., intend to build a vessel of about 1,500 tons, equipped with Diesel engines, to ply between San Francisco and the Hawaiian Islands.

The Bureau of Lighthouses, Washington, D. C., will soon advertise for bids for constructing the lighthouse tender *Palmetto*, 90 feet long, to have for motive power two gasoline (petrol) engines of 65 horsepower each.

Bids for the New Coast and Geodetic Survey vessel will be opened at the office of the Coast & Geodetic Survey, Washington, D. C., on August 10.

It is announced in the newspapers that Henry Ford, of Detroit, will enter the ore and freight carrying business on the Great Lakes. If this is true, Mr. Ford will doubtless be in the market for steamships.

According to report, J. P. Morgan & Co., of New York, together with other capitalists, are planning important development works in Alaska. When these works are carried out the necessary result will be the building of several steamships. In fact, shipyards have already received inquiries regarding vessels suitable for Pacific States-Alaska traffic.

New Steamship Companies Organized

The Inland Navigation Company has been incorporated in the State of Delaware with a capital stock of $9,000,000 (£1,845,000) to engage in the transportation of passengers and freight on the rivers, canals and lakes of the United States. One of the principal incorporators is said to be John H. Bernhard, 52 Broadway, New York.

The Marine Transport Service Corporation has been organized with offices at 17 Battery place, New York, and, it is stated, will shortly begin the operation of three separate lines of freight steamers.

One of the new lines is to run from New York through the Panama Canal to Los Angeles, San Francisco, Portland, Tacoma and Seattle. The second is to be operated from New York to South American ports and the third line is to operate to miscellaneous foreign ports, whenever business offers.

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For the first line from New York to Tacoma, the company has already chartered the freighters *Eureka* and *Tampico,* belonging to the Pacific Steamship Company. In addition, the company is now conducting negotiations for the purchase of four additional steamers.

New Shipbuilding Companies Incorporated—Expansion of Existing Shipyards

The Galveston Dry Dock & Construction Company, Galveston, Texas, has been organized and has applied to the City Commission for a lease of 600 feet of frontage as a site for a marine railway, dry docking and shipbuilding plant. It guarantees to expend $100,000 (£20,000) within two years and $150,000 (£30,750) within five years, if the lease is granted.

The James Tregarthen & Sons Company, New Hamburg, N. Y., has been incorporated with a capital stock of $50,000 (£10,250) for the purpose of building vessels. The incorporators are J. Tregarthen, J. A. Tregarthen and W. H. Tregarthen, all of Brooklyn, N. Y.

The Fore River Shipbuilding Corporation, Quincy, Mass., is receiving bids for 2,500 tons of steel for extensions to its machine shops in order that its capacity to build ships may meet the demand.

The New London Ship & Engine Company, Croton, Conn., has just let a contract for a five-story building 106 feet by 135 feet to increase the capacity of its plant, and is probably in the market for machinery.

The Lake Submarine Company, Bridgeport, Conn., has bought some adjoining land and will at least double its capacity for building submarine boats.

The Island Transportation Company, Stockton, Cal., is planning to construct a shipyard to cost about $50,000 (£10,250).

It is announced that the Clooney Construction & Towing Company, Lockport, La., has resumed work with a force of 100 men, and it is stated that the company has sufficient work on hand to keep its plant operating for a long time to come.

It has been formally announced that the Newport News Shipbuilding & Dry Dock Company, of Newport News, and the New York Shipbuilding Company, of Camden, N. J., will go into the business of building submarines. These firms have asked the Secretary of the Navy to have the advertised opening of bids on Aug. 2 for 16 submarines, authorized by the last Congress, postponed, in order that they may submit bids.

The California Shipbuilding Company, Augusta, Me., has been incorporated in the State of Maine with a capital of $5,000,000 (£1,025,000) to engage in the manufacture of, and to deal in, all kinds of vessels and equipments.

Marine Terminal Projects

Immense water-front improvements in the meadow district of Newark, N. J., are being made, under the direction of the Board of Street and Water Commissioners of that city. Most of the dredging has been started, and work is beginning on docks having a frontage of 4,500 feet, with piers, bulkheads, etc. The docks are to be equipped with cranes and various kinds of freight-handling machinery. Railroad connections will be made with the several roads entering the city. $2,000,000 (£410,000) has already been authorized by the New Jersey Legislature for this work. Morris R. Sherrerd is the chief engineer and James J. Hallock is the engineer in charge of the work.

According to press reports, bids will soon be called for by the Department of Wharves, Docks and Ferries, Philadelphia, Pa., for the construction of the first of the ten municipal piers to be known as the Moyamensing Piers, which, when completed, will cost about $1,500,000 (£307,500). The whole group, with the machinery required, will involve an expenditure of almost $25,000,000 (£5,125,000).

H. McL. Harding, consulting engineer, New York, has been authorized by the Wharf & Dock Commission, Beaumont, Texas, to prepare working plans for the first wharf and terminal improvements, including the construction of an 800-foot shed and the installation of several loading and unloading cranes and other machinery. The estimated cost is $109,000 (£22,400).

Ford, Bacon & Davis, New Orleans, La., have drawn plans and specifications for a large cotton warehouse and terminal in the city of New Orleans, to cost about $3,000,000 (£615,000). It is reported that the contract will soon be let. This terminal is to be equipped with the latest mechanical appliances for handling cotton as well as other freight.

The Pennsylvania Railroad Company, Philadelphia, Pa., is stated to be asking bids on a dock 942 feet long by 66 feet wide. Included in the equipment will be a considerable amount of coal-handling machinery.

S. M. Kearns, 625 West Ocean avenue, Long Beach, Cal., has been awarded a contract by the Board of Public Works of Long Beach to build the Belmont Pier. John Schulz, Wright & Callender building, Los Angeles, is engineer.

Emil Schacht & Son, architects, Portland, Ore., are preparing plans for Albert Brothers, Portland, for the construction of a dock and warehouse on the Willamette River. The estimated cost is $20,000 (£4,100).

Bids will be received by the Superintendent of Public Works, State of New York, at Albany, N. Y., until August 17 for terminal contracts Nos. 37 and 46 of the New York State Barge Canal.

Plans are being prepared by the Department of Public Works, Quebec, P. Q., for improving the city docks at a cost of $500,000 (£102,500).

The city of Pascagoula, Miss., has voted to spend $17,000 (£3,500) for the purpose of constructing public wharves or docks.

The city of Augusta, Ga., is receiving bids for the construction of a reinforced concrete pier and warehouse.

The California State Board of Harbor Commissioners is having plans prepared for the construction of Pier No. 11 at San Francisco.

W. P. Seaver, Inc., Grand Central Terminal, New York, has received a contract to build the 30th Street Pier at Brooklyn, N. Y., at a cost of $196,263 (£40,250).

J. A. McEachern Company, Inc., Seattle, Wash., has received a contract from the Shell Oil Company, Portland, Ore., for the construction of a dock on the Portland River front.

Henry Steers, Inc., New York, has received a contract for the construction of a new pier at the foot of 29th street, South Brooklyn, N. Y., at a cost of $116,148 (£23,800).

George B. Spearin, New York, has received a contract to build a pier at the foot of 35th street, South Brooklyn, N. Y., at a cost of $309,201 (£63,500).

Bids have been received by the Board of Trustees of Redmondo, Cal., for the construction of a reinforced concrete pier to cost about $121,000 (£24,800). George W. Harding, Los Angeles, is the engineer.

The General Chemical Company, New York, is planning to build a pier at Marcus Hook, Pa.

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Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of naval vessels for the United States navy:

BATTLEESHIPS

	Ton.	Knots.		Feb. 1.	July 1.
Nevada	28,000	20½	Fore River Shipbuilding Co...	86.4	94.2
Oklahoma ...	28,000	20½	New York Shipbuilding Co..	87.2	96.6
Pennsylvania.	31,400	21	Newport News Shipbldg Co...	67.1	81.5
Arizona	31,400	21	Navy Yard, New York.....	48.1	66.8
Mississippi ..	32,000	21	Newport News Shipbldg. Co..	6.0	23.4
Idaho	32,000	21	New York Shipbuilding Co...	9.9	32.1

TORPEDO BOAT DESTROYERS

	Ton.	Knots.		Feb. 1.	July 1.
Downes	1,010	29	New York Shipbuilding Co...	99.2	100.0
O'Brien	1,050	29	Wm. Cramp & Sons.....	93.3	100.0
Nicholson ..	1,050	29	Wm. Cramp & Sons.....	90.2	100.0
Winslow	1,050	29	Wm. Cramp & Sons.....	87.0	95.9
Cushing	1,050	29	Fore River Shipbuilding Co...	84.0	98.1
Ericsson ...	1,050	29	New York Shipbuilding Co...	92.8	99.5
Tucker	1,090	29½	Fore River Shipbuilding Co...	33.2	76.3
Conyngham .	1,090	29½	Wm. Cramp & Sons.....	54.3	78.3
Porter	1,090	29½	Wm. Cramp & Sons.....	50.8	72.5
Wadsworth .	1,090	29½	Bath Iron Works.....	78.6	97.8
Jacob Jones..	1,090	29½	New York Shipbuilding Co...	52.2	80.7
Wainwright .	1,090	29½	New York Shipbuilding Co...	51.7	80.2
No. 63	1,090	29½	Fore River Shipbuilding Co...	6.4	29.2
No. 64.....	1,090	29½	Fore River Shipbuilding Co...	6.4	28.6
No. 65.....	1,090	29½	Bath Iron Works.....	0.0	24.0
No. 66.....	1,090	29½	Bath Iron Works.....	0.0	22.6
No. 67.....	1,090	29½	Wm. Cramp & Sons.....	0.0	13.1
No. 68.....	1,090	29½	Navy Yard, Mare Island.....	0.0	4.0

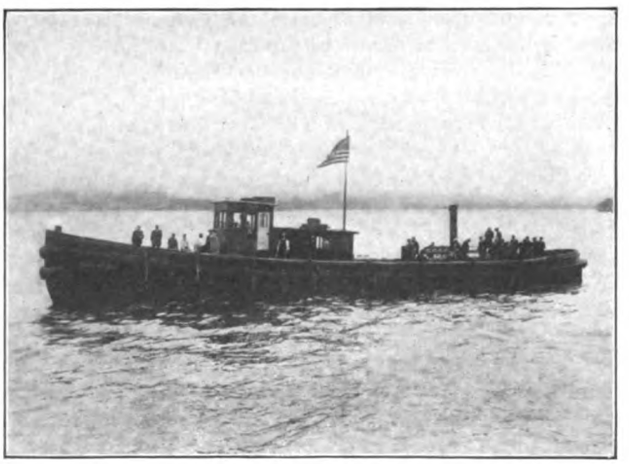
SUBMARINE TORPEDO BOATS

				Feb. 1.	July 1.
G-2	....	....	Navy Yard, New York.....	89.7	89.7
G-3	....	....	Navy Yard, New York.....	86.7	88.6
L-1	....	....	Fore River Shipbuilding Co...	89.6	98.3
L-2	....	....	Fore River Shipbuilding Co...	84.6	98.4
L-3	....	....	Fore River Shipbuilding Co...	75.5	92.7
L-4	....	....	Fore River Shipbuilding Co..	76.0	91.9
L-5	....	....	Lake T. B. Co.....	58.2	72.4
L-6	....	....	Craig Shipbuilding Co.....	52.7	63.4
L-7	....	....	Craig Shipbuilding Co.....	51.6	61.7
M-1	....	....	Fore River Shipbuilding Co...	63.4	78.8
L-8	....	....	Navy Yard, Portsmouth.....	3.0	38.7
L-9	....	....	Fore River Shipbuilding Co...	50.0	73.1
L-10	....	....	Fore River Shipbuilding Co...	45.6	71.0
L-11	....	....	Fore River Shipbuilding Co...	3.2	62.0
N-4	....	....	Lake T. B. Co.....	0.0	24.7
N-5	....	....	Lake T. B. Co.....	0.0	24.1
N-6	....	....	Lake T. B. Co.....	0.0	23.5
N-7	....	....	Lake T. B. Co.....	0.0	23.4

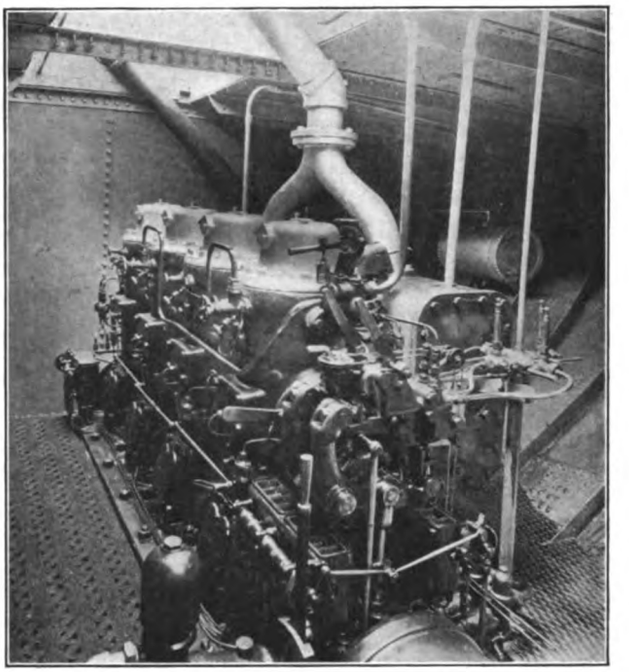
Contract Let for Big Lumber Schooner Fitted With Auxiliary Engines

C. R. McCormick, head of the McCormick Lumber Company, San Francisco, Cal., recently placed a contract with the St. Helens Shipyard, St. Helens, Ore., for a five-masted wooden schooner 265 feet long equipped with two Bolinders engines aggregating 640 horsepower. The vessel will have a capacity of over 2,000,000 feet of lumber and will cost $125,000 (£25,600). The beam will be 46 feet, the depth of hold 19 feet and the gross tonnage between 1,700 and 1,900 tons. With her auxiliary engine power she will have a speed of about 7 knots. Provision is made for carrying 800 barrels of fuel oil, which will give the vessel an operating radius of 60 days.

For handling the cargo a double set of winches will be installed, the gear being similar to that adopted on steam lumber schooners. With this machinery it is estimated that over 400,000 feet of lumber can be loaded per day, enabling the ship to take on a full cargo in five days. To facilitate loading bow and stern ports will be provided for handling long lengths of timber.



Water Boat *Aquadon*



Engine Room of the *Aquadon*

Water Boat Aquadon Fitted With Bolinders Oil Engine

The Boston Provision & Ship Supply Company, of New York, owners of the water boat *Aquadon*, which is operated in New York harbor for carrying fresh water to harbor vessels, has recently fitted the *Aquadon* with a 100 brake horsepower, four-cylinder, direct-reversible Bolinders fuel oil engine, designed to give the vessel a speed of about 8 knots light and 7 knots loaded, with a guaranteed consumption of fuel oil of .63 pound per horsepower hour. In the engine room are four cylindrical tanks, one on the starboard side forward, 16 inches diameter by 30 inches long, with a connection to the water injection pumps on the main engine, and a filling pipe from the fresh-water service pumps. On the starboard side aft is a fuel service tank 16 inches diameter by 36 inches long with connections to the fuel injection pumps on the main engine arranged to be filled by a pump drawing from the main fuel storage tank, which is located in the extreme after end of the boat. On the port side aft is a compressed air tank, 12 inches diameter by 5 feet long, used for storing air at 120 pounds per square inch for starting the engine. On the port side forward is a tank also 12 inches diameter and 5 feet long, used as a whistle tank. As such, it is connected to the starting tank and also to the recharging valve on the after cylinder of the engine.

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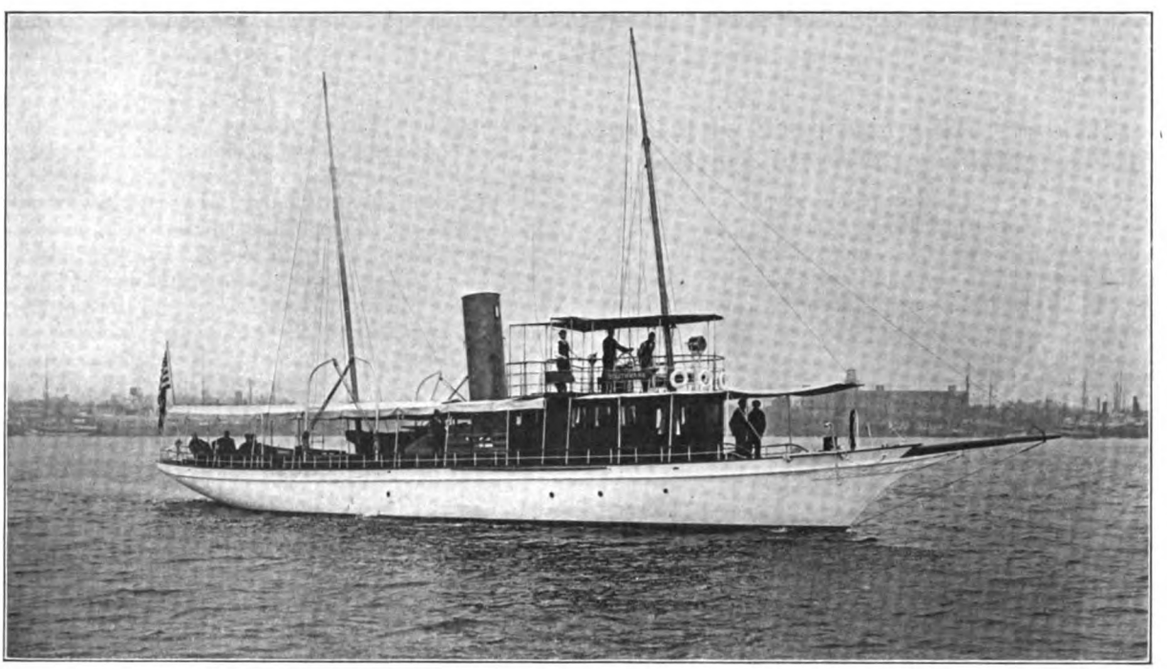
The exhaust gases from the engines are carried from the silencers up into a funnel, the top of which is 12 feet above the deck. The hull of the vessel, which is 102 feet long, 22 feet beam and 8 feet 6 inches depth, is divided into five compartments by four watertight bulkheads. The forward compartment is the general locker, the second and third are water tanks with a total capacity of 160 tons for carrying fresh water, the fourth is the engine room and the after compartment a storage tank for fuel oil.

The water service pump for the rapid handling of the cargo of fresh water is situated on the starboard side of the engine room and is driven by a belt from the main engine.

Yacht Southwark Equipped with Southwark-Harris Valveless Oil Engine

A 4-cylinder, 240-indicated horsepower Southwark-Harris oil engine (described on page 390 of our September, 1914, issue) has just been installed in the yacht *Southwark*, owned by C. P. Vauclain, of Philadelphia. The yacht is 98 feet long overall by 16 feet beam and 7 feet draft. On her initial trial trip she made a speed of about 10 miles per hour against the tide and a head wind, with the engine turning at 225 revolutions per minute. On a run of 35 miles, from Philadelphia to Chester, Pa., and return on June 26 twenty-nine gallons of Mexican oil at an approximate fuel cost of less than 75 cents (3/1½) was used, the time for the run being 3 hours 20 minutes. The engine is manufactured by the Southwark Foundry & Machine Company, Philadelphia, and is designed to give the vessel a speed of 12 miles per hour, using 7½ gallons of fuel per hour, at a cost of 18¾ cents (0/9¼) per hour. The capacity of the fuel tanks is 1,400 gallons, giving the yacht a cruising radius of 2,200 miles.



Yacht *Southwark*, the First Vessel to be Equipped With a Southwark-Harris Oil Engine

Trial Trip of the Motor Ship San Francisco

The official trial trip of the motor ship *San Francisco*, built by Burmeister & Wain, Copenhagen, for the Rederiaktiebolaget Nordstjernan, Stockholm, was carried out in Copenhagen Sound on June 12. The *San Francisco* is a sister ship of four others already completed for the same company, having the following dimensions: Length between perpendiculars, 362 feet; beam, 51 feet 3 inches; depth from awning deck, 34 feet; deadweight capacity, 6,550 tons. Propulsion is by twin screws actuated by two four-stroke, single-acting engines, each having six cylinders capable of developing 2,000 indicated horsepower continuously under normal load, giving the ship a speed of 10 knots. The ship is further equipped with two auxiliary engines each developing 200 brake horsepower, which drive the air pumps and dynamos for working all the auxiliary machinery, including the steering gear, and supplying current for electric light. All the cargo winches are also electrically driven. The auxiliary Diesel engines are in duplicate, each being of sufficient capacity so that it can supply all the needs while the other is standing by as a "spare."

During the trial trip the vessel attained a speed of 10.62 knots with the engines developing 1,885 indicated horsepower at 151 revolutions per minute. The consumption of fuel oil averaged 58.61 pounds per hour with the engines developing 1,863 indicated horsepower, giving a consumption of .315 pound of fuel oil per indicated horsepower hour of the main engines, including the consumption for all the auxiliary machinery. As the mechanical efficiency of the main engines has been determined in the testing shops of the builders to be .85, the consumption per brake horsepower of the main engines works out at .37 pound. The fuel used was Solar oil.

The owners of the *San Francisco* have placed an order with Burmeister & Wain for four additional motor ships, making in all ten motor ships in this company's fleet.

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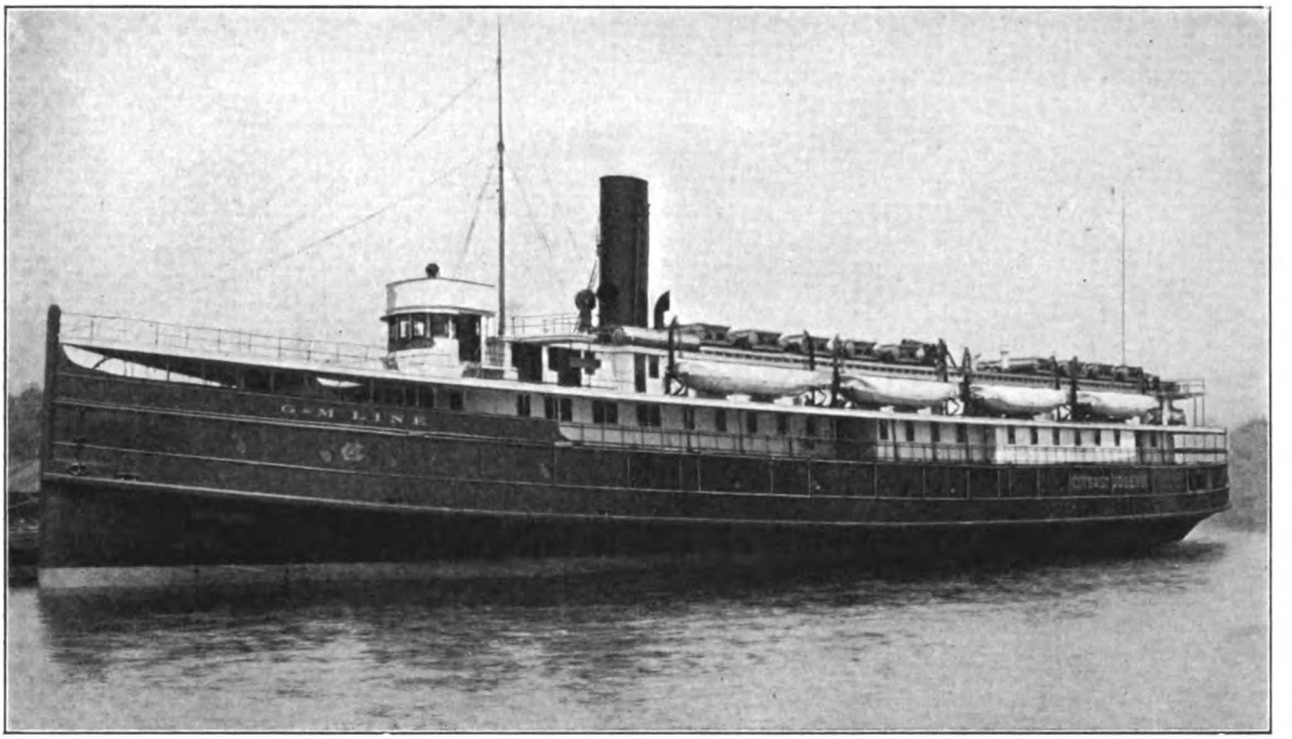
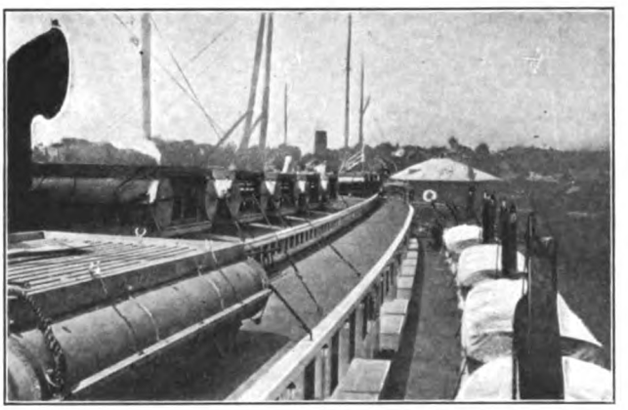


Graham & Morton Transportation Company's Steamer *City of St. Joseph*, Fitted with New Life-saving Equipment

Lake Steamer Fully Equipped with Lundin Lifeboats and Welin Davits

The freight and passenger steamer *City of St. Joseph*, of the Graham & Morton Transportation Company, Chicago, Ill., has recently been equipped with life-saving apparatus in accordance with the latest United States laws conforming to the requirements prescribed at the recent International Conference on Safety of Life at Sea at London. The equipment includes eight 24-foot, 40-person Lundin standard steel lifeboats and fifteen 25-person Lundin life rafts. The boats are of the open-type, each boat being placed under a separate set of Welin quadrant davits.



Welin Davits and Lundin Lifeboats on the *City of St. Joseph*

Among the principal advantages of this type of lifeboat is the fact that although they are self-bailing, they have four or five times the tank capacity required by the new rules. They are also fitted with balsa wood fenders, which not only prevent damage to the boat in smashing against the side of the ship, but also add to the buoyancy and stability of the boat. The manufacturers claim that such boats will in emergency take care of twice their capacity without endangering their stability or buoyancy. Provision is made as far as possible for the safe launching of the boats when the vessel is either upright or listed by using the Welin davits, but if for any reason the boats cannot be launched by the davits they can be cut loose and depended upon to float off the deck if the vessel sinks, thereby making the full lifeboat equipment available for rescue work.

Recent Launchings

The steel hull for the ferryboat *Fort Lee*, a screw boat 200 feet long, 40 feet beam, molded, and 65 feet beam over guards, was launched by the Harlan & Hollingsworth Corporation, Wilmington, Del., on June 29. The vessel is being constructed for the Public Service Corporation of New Jersey, the machinery being supplied by W. & A. Fletcher & Co., of Hoboken, N. J.

The dipper dredge *Cascadas*, designed by the Bucyrus Company, South Milwaukee, Wis., for the United States government for use on the Panama Canal, was launched in the yards of the New York Shipbuilding Company, Camden, N. J., June 26. The dredge is equipped with double-tandem compound engines, 16 inches and 28 inches diameter, with a stroke of 24 inches, designed to exert a maximum pull on the hoisting rope of 235,000 pounds. This is said to be the largest and most powerful dipper dredge in the world.

The torpedo destroyer *Conyngham*, one of the six destroyers authorized in the last naval appropriation, was launched at the yards of the William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., July 8. She will have a speed of 29½ knots.

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ENGINEERING SPECIALTIES

Marten-Freeman Compensating Davit

The problem of proper and efficient handling of lifeboats is now receiving considerable attention, owing to the new legislation which has, in effect, condemned the old system of round-bar davits and which requires the installation of a suitable mechanical device to insure the best possible results from the lifeboat equipment in time of need. "Best possible results" means the positive ability to get all lifeboats overside in the shortest possible time and with the least amount of effort, all to be capable of accomplishment under severe conditions. As positive action and general efficiency are the requirements of a mechanical davit, the following description of the Marten-Freeman compensating davit is of interest.

Marine engineers have frequently stated that the ideal davit would be one involving a minimum of sliding or rubbing friction with rolling friction substituted therefor under the main loads and stresses—i.e., a so-called track and trolley system, as, under these conditions, the theoretical power required to displace the boat from the inboard to the outboard position would be at a minimum. The Marten-Freeman compensating davit might be termed a track and trolley davit, inasmuch as that system is used for carrying the moving loads. The fundamental principle involved in the device, however, is apart from the track and trolley.

The davit consists of a cast steel frame forming a track and supports, a steel trolley of the tandem roller type, which rolls along the track and carries the steel boom at its fulcrum, the compensating link and the bronze actuating screw and crank. The screw engages a bronze nut which "floats" in the trolley in such a manner, it is claimed, that a deflection in the frame, climatic change, or obstruction on the track cannot cause the screw to bind, there being sufficient freedom in all directions. The flanged tandem rollers are designed to distribute the load over the track and render tilting of the trolley frame impossible. The track is narrow, and it appears impossible to impede the operation of the davit by foreign matter on the track, as the rollers are small, the track smooth, and any obstruction is readily pushed or sheared off. It is quite obvious that it would take tremendous resistance from ice, other foreign matter, or loose gear to obstruct the action of the link. Another feature affecting the element of safety is that the compensating link forms an unbroken mechanical connection at the inner end of the boom at all stages of the operation. The boom is so constructed that it forks over the frame and screw, thus tending to keep all stresses set up within the davit along a centerline, and the boom is firmly supported at its foot. The bronze actuating screw is amply protected from injury by a steel tee and all bearings are of non-corrosive metals.

The seat of the mechanical principle is in the compensating link which connects the foot of the boom to a fixed center at the base of the frame, and the functions of this link, with its differential compensating action, are clearly illustrated in the accompanying diagram, which shows the relative positions of the boom and link when the fulcrum is advanced through uniform intervals. It also shows the differential and compensating action of the link, which results in greatly reduced thrust on the screw and accounts for the comparatively small amount of power required to operate the davit. The diagram also indicates the direction (not the magnitude) of the resultant force due to a vertical load at the boom head and assuming that the screw is removed. The thrust along the screw is equal to the horizontal component of that force. Therefore the nearer vertical the resultant force is maintained the less the stress along the screw, and the less the operating power required for any given moment.

The theoretical direction of the resultant force for any given position is obtained by a line drawn through the fulcrum to the point of intersection of a vertical line through the boom head and a line drawn through the link centers. When the boom is vertical there is no overturning moment, the resultant force is vertical and there is no thrust on the actuating screw. In this position the link is almost horizontal, assumes no load, and

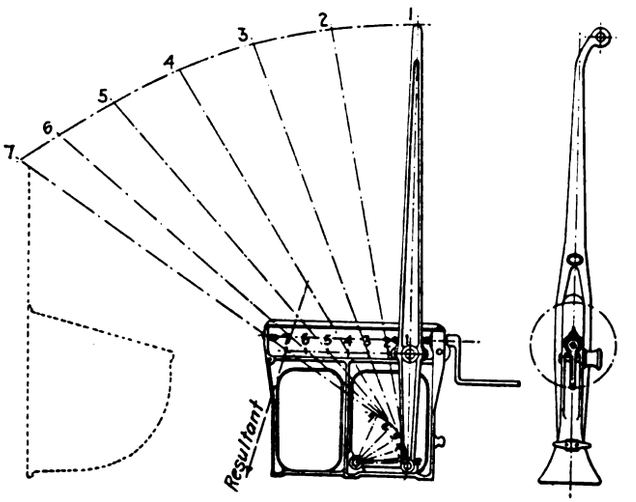

Fig. 1.—Diagram Illustrating the Principle and Action of the Marten-Freeman Compensating Davit

does not affect the direction of the resultant force.* As the boom is extended the overturning moment of the load increases, but during this action the link comes immediately to a position to assume tension and to act as a partial counter to the overturning moment of the load. During the early stages of movement from the vertical the overturning moment is small, due to the slight angularity of the boom. As the operation proceeds, however, the angularity of the boom increases, and the moment

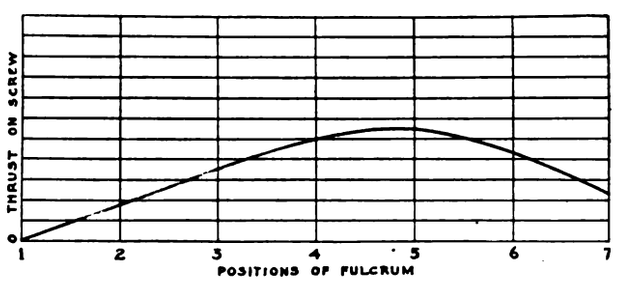

Fig. 2.—Curve Showing Variation in Thrust on the Screw Due to the Compensating Action of the Link

increases in consequence; but it is seen from the diagram that, for uniform intervals of advance of the fulcrum, the increase in the angularity of the boom (and consequently the increase in the overturning moment) is lessened in ratio. At the same time the link is brought more and more rapidly toward the vertical and, in consequence, is acting more and more as a counter to the overturning moment, thus keeping the thrust on the screw at a minimum, and consequently the effort required to operate the

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davit is correspondingly small. When a point slightly beyond mid-position is reached the counter effect of the link, due to its differential action, increases more rapidly than does the overturning moment, due to the increasing angularity of the boom, and from that point on the thrust on the screw is rapidly reduced.

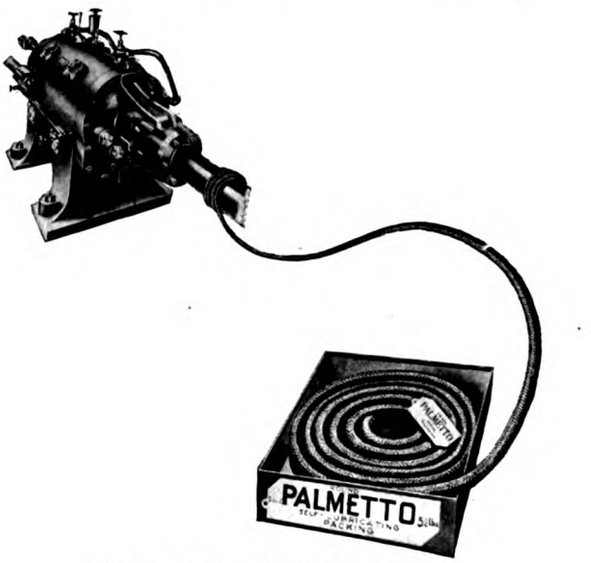
The curve in Fig. 2 illustrates the variation in the thrust on the screw assuming a dead load at the boom head, and it is apparent from this curve that the thrust is at a minimum in both extreme inboard and outboard positions, thus allowing the available power to be used in overcoming the inertia of the load in starting either inboard or outboard. The davit is so proportioned, and the centers so located, that the maximum thrust on the screw is relatively low, which accounts for the ease and rapidity with which lifeboats under this system can be launched. The curve further shows that with this system greater outreach can be obtained without increasing the length of the boom, inasmuch as the angularity of the boom in the outboard position can be increased without increasing the thrust on the screw. As a matter of fact, this can be accomplished with an actual further reduction in the stresses along the screw. The system throughout tends toward equilibrium, and the effort required in launching the boat is in proportion to the condition of equilibrium maintained. The diagram also shows the path of travel of the boom head, and it will be noted that this line becomes flatter as the boom is extended and as the link approaches a vertical position the amount of drop of the boom head is decreased in proportion to its extension.

This davit is manufactured in a number of sizes and types designed to meet all possible conditions for the proper and efficient launching of lifeboats with safety and in the least possible time, and the mechanical principle involved in its construction is such that it lends itself admirably to meet satisfactorily many unusual conditions in the handling of such equipment. This device is being marketed by C. J. Hale, 17 Battery place, New York.

Palmetto Packing for Air Compressors

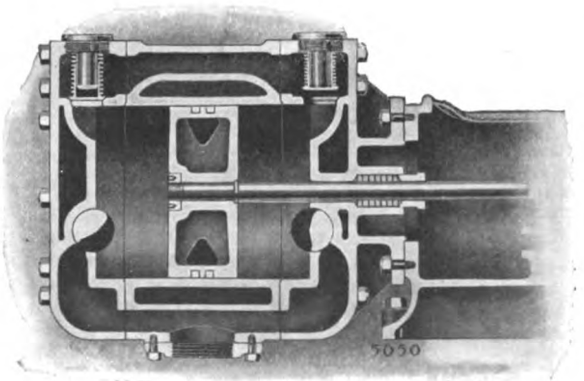
One of the difficulties commonly encountered in compressed-air plants is the leakage of air due to the deleterious effect of the high temperatures of compressed air on the packings commonly used in air compressors, air valves and line connections. The dry heat of compressed air causes packings made of vegetable matter to char and deteriorate. Asbestos packings usually used harden too quickly into a rock-like substance, which not only causes excessive wear on the rods upon which they work, but which also destroys their usefulness as packing and causes wasteful leaks.

Because of the heat conditions, a packing for compressed-air apparatus must not only be of mineral substance, but must remain soft and pliable in service. The "Palmetto" packing, manufactured by Greene, Tweed & Company, New York City, it is claimed, meets such conditions satisfactorily, because it is made of a mineral substance having great tensile strength and is kept from hardening by a special process whereby a compound of graphite grease is so injected into the center of each single strand of the packing that it separates the particles of asbestos and so prevents it from amalgamating back into the rock from which it was fiberized. In other words, the lubricant supplies the necessary moisture to overcome the heat-destroying tendency of compressed air.



Palmetto Packing for Air Compressors

On account of its materials and the peculiar process of its manufacture, "Palmetto" packing, it is claimed by the manufacturers, is peculiarly adapted for long service in compressed-air apparatus.



Section Through Air Cylinder Showing Position of Packing

The Turbo-Gear

The Turbo-Gear Company, Baltimore, Md., has placed on the market a speed transformer which can be used either as a speed-reducing or speed-increasing gear. The gear consists of a large internal double helical gear, a double helical pinion and intermediate double helical gears. The slow-speed member, to which is secured the slow-speed shaft, is mounted on two heavy-duty ball bearings, one on each side of the gears, and supported directly by a heavy housing. With this arrangement the slow-speed member and the shaft carrying the intermediate gears and the high-speed shaft and pinion are independent of each other for support, and each is supported directly by the housing.

The high-speed shaft has a central passage through which oil is pumped, and a continuous stream of oil is sprayed on the gears through radial passages in the pinion. The high-speed bearings, besides having forced feed lubrication, are provided with oil rings and a good-sized oil reservoir for emergency use. It should be noted that the

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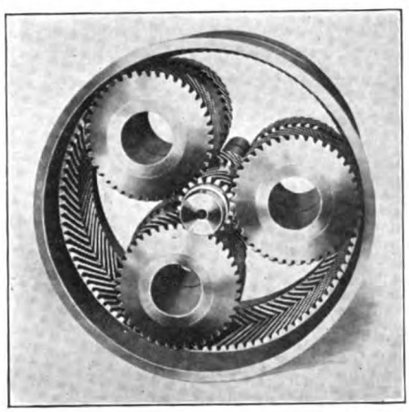
gears do not run in oil but are being sprayed by a continuous stream of oil under pressure.

It is claimed that the turbo-gear has an efficiency of not less than 95 percent for any speed ratio and that it is especially suited for marine work, either for transmitting power from a high-speed turbine to a slow-speed

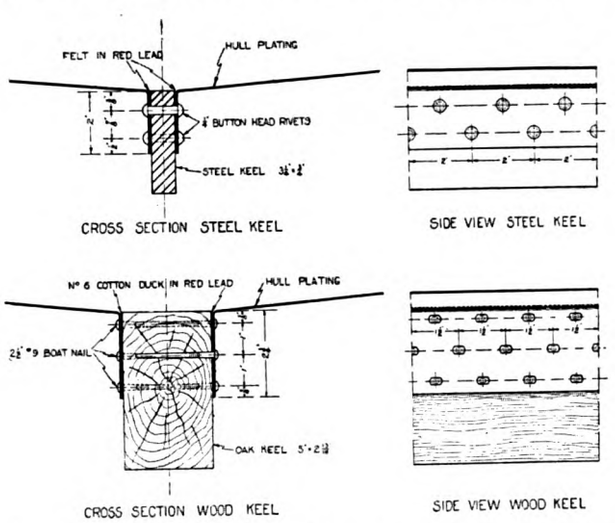


Turbo Gear

propeller, or in connection with various auxiliaries on board ship, such as high-speed electric motors for driving air compressors, refrigerating machinery, blowers, etc. At present the turbo-gear is built in one size only, which is capable of transmitting various powers up to 75 horsepower.

Advantages of Steel Keel for Metal Lifeboat

The advantage of building a metal lifeboat on a steel keel, rather than on a wooden keel, is explained by the



Sketches Showing Difference in Construction of Wooden and Steel Keel Metallic Lifeboat

Welin Marine Equipment Company, Long Island City, New York, as follows:

As is generally known, wood checks and warps, and for that reason it is extremely difficult to insure permanent tightness where the garboards are joined to the wooden keel. Besides, as shown by the drawing, there is the obvious danger that the nails, which extend through the garboards into, but not wholly through, the wooden keel, will pull out when the boat is heavily loaded, particularly when the excessive expansion and contraction of the wood, due to the elements, are considered, as compared to the steel. As regards lasting qualities, the difference in favor of the steel keel is very obvious when it is borne in mind that on account of the acid that the wood contains and also the possibility of leakage the plating will deteriorate very much quicker when the boat is built on a wood keel. With the steel keel there is a decided advantage over the construction of steel ships, the keel being made of rolled steel and the plating galvanized iron, which will considerably reduce the danger of rusting.

Barnsley Automatic Wrench

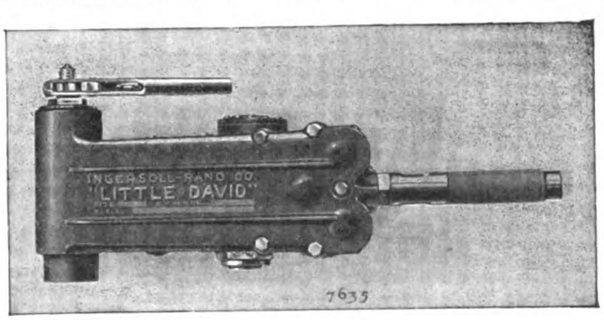
The Barnsley automatic wrench, manufactured by the Automatic Wrench Manufacturing Company, Inc., Boston, Mass., comprises only three parts—a jaw, handle and clutch. The automatic action of the wrench is brought about by an ingenious clutch arrangement. The clutch has a neutral position which allows the jaws to move freely in and out. To operate the wrench the object to

New Automatic Wrench

be turned is placed between the jaws and the jaw either pressed in or drawn in with a thumb trigger under the handle until the jaw strikes the object where it is locked by the clutch. The harder the pull on the wrench the tighter is the locking action. To open the jaws, or to release the jaws from the object, it is only necessary to exert a slight pressure on the clutch when the jaws spring open, or, closing the jaws together releases the clutch and the jaw is self-opening. The clutch is made in one piece and, it is claimed, is unaffected by oil or grease, making it impossible for the wrench to "freeze" on a nut. The wrench illustrated is 10 inches long when open, and fits nuts up to 1¾ inches. It is useful for any purpose where an ordinary monkey wrench is used.

A New "Little David" Drill

The "Little David" close-quarter drill illustrated, which is manufactured by the Ingersoll-Rand Company, New



Close-Quarter Drill

York, is particularly adapted for working in cramped or confined positions where the regular type of four-piston, reciprocating, pneumatic drill cannot be used. The distance from the end of the casing to the center of the

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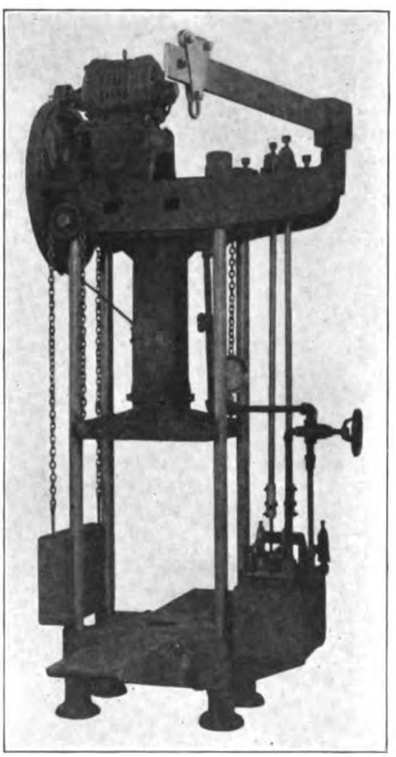
spindle is only 1 5/16 inches. The motor is of a novel, three-cylinder design, and operates in a bath of oil. The valve is of the rotary type, gear-driven from the pinion of a three-way crank-shaft, which is operated by three ratcheted levers which directly connect the pistons to the drill spindle. It is claimed that there is practically no strain on the crank-shaft, as the power is transmitted direct from the pistons through the levers to the ratchet spindle. The fact that the spindle has a triple-ratchet, so that one of the ratchets is engaged on the spindle at all times, makes it possible to develop more power and maintain a much more constant pull on the spindle. The casing is divided in such a way that the loosening of a few cap screws allows easy access to all moving parts, and the manufacturers claim that the drill can be dismantled and completely reassembled in thirty minutes. The drill is fitted with a No. 4 Morse taper socket, is rated for drilling up to 3 inches and reaming and tapping to 2 inches, and operates at a speed of 150 revolutions per minute.

60-Ton Self-Contained Inverted Hydraulic Forcing Press

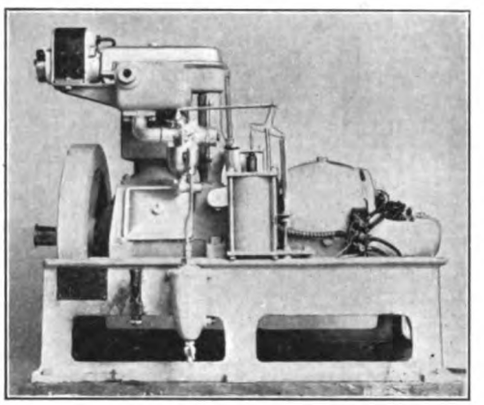
The hydraulic press illustrated is a new design of inverted hydraulic forcing press brought out by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio. It is used as a general utility press for forcing work, and is a self-contained unit which requires no auxiliary water or power supply. It is driven either by an electric motor or by belt. The press is equipped with a two-plunger vertical hydraulic pump whose plungers are 5/8 inch in diameter and have a stroke of 3½ inches. This pump is driven through two eccentrics which are operated by a 3 horsepower motor mounted upon the press. The lower platen, which is close to the floor, has a pressing surface 24 inches by 22 inches, with a hole in the center 6 inches in diameter, to take the end of the hub or shaft during the pressing operation. The movable platen of the same size is guided in its travel by babbitted bearings on the strain rods. The ram is returned after the pressing operation by a weight.



60-Ton Forcing Press

Matthews Marine Lighting Sets

The Matthews Boat Company, Port Clinton, Ohio, well-known builders of motor boats, have placed on the market a light, compact and reliable electric-lighting set especially designed for pleasure and work boats and as auxiliary sets for steam vessels. The sets are made in sizes ranging from 1 to 2½ kilowatts capacity, the set illustrated being a 1-kilowatt plant capable of supplying current for fifty lights. The generator is direct connected to a single-cylinder gasoline (petrol) engine.

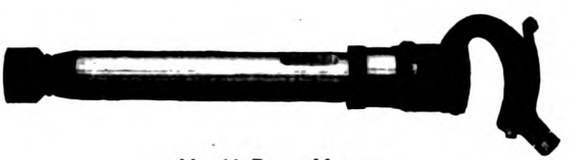


1-Kilowatt Lighting Set

New Pneumatic Hammer

An improved form of the Boyer Hammer has just been placed on the market by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago. This hammer, which is No. 11, has a piston diameter of 1 3/16 inches, with a stroke of 11 inches and a capacity for putting down 1½-inch rivets. It strikes 700 blows per minute and weighs 31½ pounds. Owing to the extremely heavy blow of this hammer and the unusually severe blow it inflicts on the rivet sets, the so-called Parker set is used. The Parker set has a wide, tapering shoulder which, it is claimed, enables it better to absorb and withstand the effects of the heavy blows.

In common with the standard form of the Boyer hammer, this tool is divided into three distinct members—handle, cylinder and valve—which make for quick examination and economical upkeep and repairs.



No. 11 Boyer Hammer

"Parker" Rivet Set

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PERSONAL MENTION

Operating Engineers

John McGraw, of Albany, N. Y., has been appointed chief engineer of the tug *Dr. David Kennedy*.

William Wells, of Albany, N. Y., has been appointed first assistant engineer of the tug *William H. Kinch*.

Frank Matte has resigned as chief engineer of the tug *George Van Tuil*, of the Cornell Steamboat Company.

Ambrose Van Wie, formerly chief engineer of the towboat *M. A. Knapp*, has accepted a position with the Cornell Steamboat Company on the tug *George Van Tuil*.

John Edward Burlingham has been appointed chief engineer of the fast freight steamer *Edward F. Murray*, of Albany, N. Y., which went into commission on July 12.

James La Coy, formerly first assistant engineer of the tug *Wm. H. Kinch*, has been appointed chief engineer of the steamer *M. A. Knapp*, of the Great Lakes Dredge & Dock Company.

Henry Lampman, of Albany, N. Y., formerly first assistant engineer of the steamer *M. A. Knapp*, has been appointed first assistant engineer of the freight steamer *Edward F. Murray*.

Frank Gosselin has been appointed chief engineer of the steamer *Mary Gordon*, of the Manhattan Navigation Company, which runs from Albany to Troy, N. Y. This steamer formerly ran from Mamaroneck to New York City.

John Pardee, of South Rondout, N. Y., chief engineer of the tug *W. B. McCollough*, which recently left Rondout for Albany, N. Y., was seriously injured on July 10 by having his leg caught in the shaft of the tug.

Naval Architects, Consulting Engineers and Shipyard Officials

Naval constructors William B. Ferguson, Jr., John E. Otterson and George S. Radford, of the United States Navy, have resigned to accept positions with private firms.

Andrew Fletcher, president of the W. & A. Fletcher Company, Hoboken, N. J., has been elected as one of the directors of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the ensuing year.

Colonel J. C. Sanford, U.S.A., secretary and disbursing officer of the American section of the Permanent International Association of Navigation Congresses, has removed his office from the old Custom House, Detroit, Mich., to the Custom House, New Orleans, La.

James Adamson recently retired from the post of engineer superintendent of the British India Company's steamers at the Royal Albert Docks, London. After serving an apprenticeship in Glasgow and studying at Glasgow University, Mr. Adamson served for several years as draftsman for various shipbuilding and engineering companies, becoming a chief draftsman. After a few years of sea experience he became identified with the British India Company at the docks, acting as assistant and, for the last twenty years, as superintendent engineer. Mr. Adamson was one of the founders of the Institute of Marine Engineers, and has been its honorary secretary since the Institute was founded.

Supply Men

E. E. Baker, formerly New York representative of the Eckliff Automatic Boiler Circulator Company, of Detroit, Mich., has been transferred to the Detroit office of this company.

G. W. Williamson, Jr., formerly of the American Engineering Company, Philadelphia, Pa., has opened an office in the Singer building, New York City, to handle several marine specialties, among which is the Eckliff automatic boiler circulator manufactured by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich.

Ralph T. Coe, manager of the Canadian Sirocco Company, Ltd., of Windsor since the organization of that company, has resigned to enter the engineering service and sales field in New York State. Mr. Coe has been appointed district manager for Warren Webster & Co. and the American Blower Company, and will have offices at 519 Insurance building, Rochester, and 19 Live Stock Exchange building, Buffalo.

OBITUARY

Lawrence Dempsey, owner of the Dempsey Literage & Transportation Company, New York, died at his home in Brooklyn on July 18.

Thomas Clapham, a retired yacht builder and prominent in yachting circles, died on July 19 at his home in Roslyn, Long Island, from heart disease, at the age of seventy-six.

Captain John W. Ferrett, for the past twenty years managing owner of the Bridgeport Towing Company, died at his home in Bridgeport, Conn., on July 18, aged fifty-nine.

Dr. Joseph Austin Holmes, Director of the Bureau of Mines, Department of the Interior, died of tuberculosis at his home in Denver, Col., on July 13, aged fifty-five.

R. C. Scott, secretary-treasurer of the Morris Machine Works, Baldwinsville, N. Y., builders of dredging machinery, died suddenly on July 4 while participating in a golf tournament. Mr. Scott was sixty-six years of age.

John Brown Herreshoff, president of the Herreshoff Manufacturing Company, Bristol, R. I., died on July 20 as the result of a general breakdown. At the time of his death he was seventy-four years old. Mr. Herreshoff became blind when he was fifteen years old, but in spite of this handicap started a shipyard at Bristol for building small boats. In 1873 his brother, Nathaniel Greene Herreshoff, joined him in this enterprise and they began the construction of fast steam vessels. In 1893 the Herreshoffs turned out their first America Cup defender, the *Vigilant*, and since then every other cup defender has been a Herreshoff boat.

Sir Nathaniel Barnaby, K.C.B., formerly director of naval construction of the British Admiralty, died on June 15 at his home in Lewisham. Sir Nathaniel was an honorary vice-president of the Institution of Naval Architects. He was born at Chatham in 1829 and was one of a family of shipwrights who had served in the Royal Dockyard at Chatham for several generations. When only twenty-five years of age he became Admiralty overseer of H. M. S. *Viper* and *Wrangler*, building on the Thames in 1854. From 1870 to 1885 he was head of the designing and building departments in the offices of the controllers of the navy. Finally he held the position of director of naval construction. Sir Nathaniel Barnaby published several volumes dealing with the historical side of the profession of naval architecture. He was one of the founders of the Institution of Naval Architects and a valued contributor to its Transactions.

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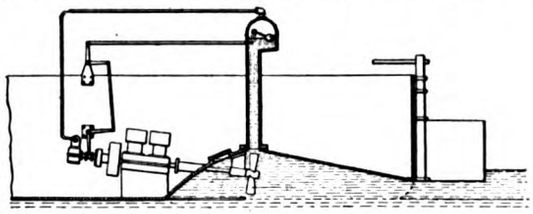
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Derbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,132,923. SHALLOW WATER BOAT. CARL H. FOWLER, OF NEW YORK, N. Y.

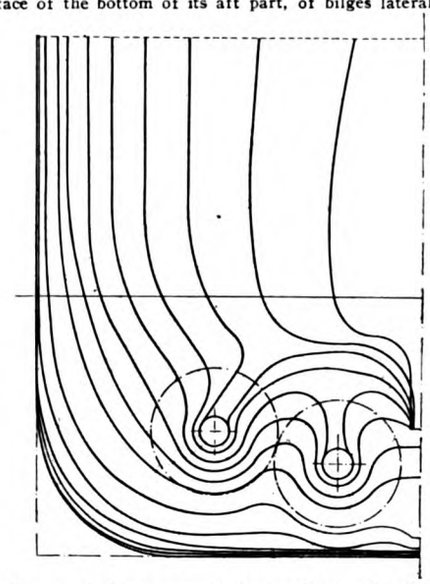
Claim 1.—A boat having a propeller chamber open at the bottom and having a rear wall, the upper part of which slopes at a gradual angle from the horizontal downwardly and rearwardly to the stern of the boat, and extending through the stern with an orifice below the minimum waterline of the boat and above the keel line, a standpipe superimposed



above and connected with said propeller chamber, a vacuum pump, a float in the upper part of said standpipe, and connections between said float and pump such that under certain conditions the pump is set in operation to exhaust the air from said standpipe and propeller chamber and under certain other conditions the pump is rendered inoperative. Ten claims.

1,136,888. SHIP'S HULL. LOTHAR VON KOPPEN, OF STETTIN-ON-THE-ODER, GERMANY.

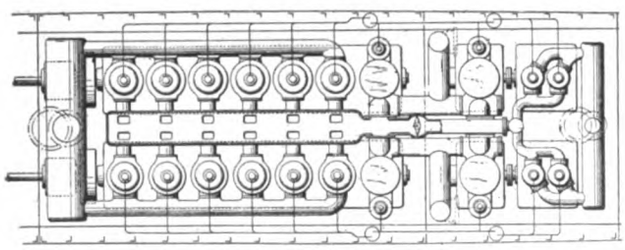
Claim.—In a hull for a ship propelled by three or more propellers, the combination with a plurality of longitudinally extending hollows in the lower face of the bottom of its aft part, of bilges laterally bounding



the said hollows and forming propeller shaft tunnels, the inner shaft tunnel or tunnels ending in front of the outer ones, substantially as set forth.

1,138,077. MARINE ENGINE INSTALLATION. ALFRED BUCHI, OF WINTERTHUR, SWITZERLAND, ASSIGNOR TO BUSCH-SULZER BROS. DIESEL ENGINE COMPANY, OF ST. LOUIS, MO., A CORPORATION OF MISSOURI.

Claim 1.—In a power plant, the combination of Diesel engines arranged in parallelism at opposite sides of a longitudinal center line, there being

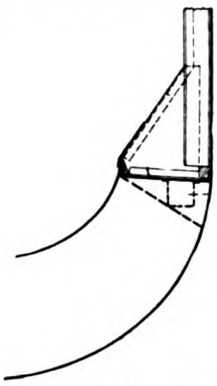


two engines at each side of the center line spaced from each other longitudinally, air pumps located in the spaces between the engines at each side of the center line, and a common scavenging air distribution system supplied by said pumps and arranged between the two proximate sides of the power plant. Six claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

5,517/1914. IMPROVEMENTS IN AND RELATING TO SHIP CONSTRUCTION. R. S. JOHNSON, EIRENE, FORTWILLIAM PARK, BELFAST, AND WORKMAN, CLARK & CO., LTD.

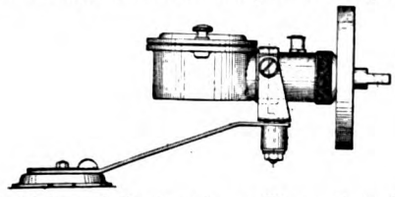
This invention has for its object to provide improvements in the method of constructing the bilges or gutters of ships of the class having their tanks or double bottoms carried out to cover part or all of the turn of the bilge or carried up the sides of the ship for some distance. According to the invention a bilge or gutter is formed above the extremity of the turned-up end of the double bottom or tank at the sides of the ship,



so that, without recessing, the extremity or the upper end of the double bottom or tank forms the floor of the bilge or gutter, the ship's side forming one side of the bilge or gutter whilst the other and inner side thereof is formed by continuous plating secured to the stays or brackets which connect the upper end of the tank or double bottom with the ship's side frames, the continuous plating being extended upwards from the floor of the bilge or gutter to any desired height. By this method of construction a bilge or gutter of any required capacity can be obtained and the plating which forms the inner side of the bilge or pumping gutter also serves to strengthen and stiffen the brackets or staying between the side frames of the ship and the extremity or the turned-up end of the tank in double bottom.

10,883/1914. IMPROVEMENTS IN SHIPS' LOGS. T. WALKER & SON, LTD., AND T. S. WALKER, OF 58, OXFORD STREET, BIRMINGHAM.

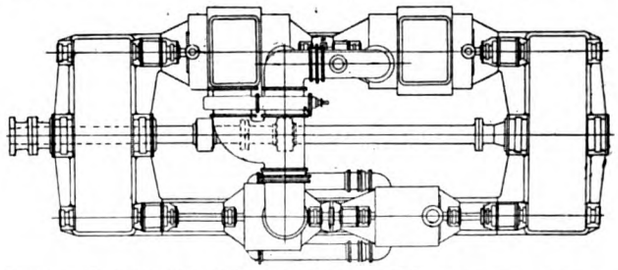
This invention relates to ships' logs and it has for object to render a log more conveniently read than is possible with the constructions at present in use. The log with its dial is capable of being adjusted angu-



larly to the axial line of the trunnions. The portion of the body of the log register is frictionally mounted in a trunnion ring carrying trunnions working in bearings in the gimbal, which gimbal is pivoted in a bearing on the outrigger. Ths outrigger is rotatably mounted on the dished taffrail plate, which is adapted to be fixed to the side of the vessel. The trunnion ring in which the body of the log register is frictionally mounted is provided with an internal spring so as to produce sufficient friction to prevent accidental turning of the register after the position of the dial of the register has been angularly adjusted.

18,105/1914. IMPROVEMENTS IN AND RELATING TO MACHINERY FOR THE PROPULSION OF SHIPS. W. D. McLAREN AND G. M. WELSH, 124, ST. VINCENT STREET, GLASGOW.

The object of this invention is to provide an arrangement of geared turbine propelling machinery whereby the torque is transmitted to the propeller shaft through two independent spur wheels driven by pairs of turbines. Each pair of turbines is arranged on a common axis so that, while the rotors are completely or partially balanced against steam



thrusts without the use of dummy pistons, and in a known manner, one rotor may transmit torque independently of the other. The drawing shows an arrangement of two gear cases containing wheels driven by four pinions from a high-pressure turbine, an intermediate-pressure turbine, and two low-pressure turbines.

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